APPENDIX Q

Essential Fish Habitat Assessment

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Essential Fish Habitat Assessment

Donlin Gold Project
Draft Version 2.1

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EXECUTIVE SUMMARY

Donlin Gold LLC (Donlin Gold) submitted a Section 10, Rivers and Harbors Act, and Section 404, Clean Water Act, preliminary permit application to the US Army Corps of Engineers to develop an open pit, hardrock gold mine approximately 10 miles north of the village of Crooked Creek, in western Alaska. The proposed Donlin Gold Mine Project (Project) has three primary components: 1) mine site facilities, 2) a 315-mi (507-km) natural gas pipeline, and 3) transportation infrastructure. These three components define the Project Area that potentially affect Essential Fish Habitat (EFH) for the species regulated under a federal Fishery Management Plan (FMP). This document presents the findings of an Essential Fish Habitat assessment of the proposed Project and is intended to support EFH consultation under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) of 1996.

The proposed Project would affect aquatic habitat that support different species and life stages of salmon summarized below:

1. Streams adjacent to the mine site support spawning by Chinook, coho and chum salmon and rearing by juvenile Chinook and coho salmon. Adult pink salmon and sockeye salmon can be present in low numbers. Project effects to EFH species from mine facilities are judged to range from low to moderate. Impacts are expected to be low in Crooked Creek downstream or away from the mine site area, where the impacts are primarily the result of reductions of flow and increased sedimentation. Moderate impacts are associated with loss of Chinook and coho rearing habitat through direct loss of two creek channels and the effects of reduced flow in Crooked Creek. Rearing stages of these two species are present in low densities in streams that will be affected by Project activities. Coho spawning habitat will likely be reduced in Crooked Creek adjacent to the mine area due to the estimated stream flow reductions.

2. The natural gas pipeline will cross numerous streams containing habitat used by the five species of Pacific salmon (Chinook, chum, coho, pink and sockeye). Potential effects of the natural gas pipeline on EFH species are judged to be low because most construction will be conducted during winter when salmon are not present. The few streams requiring summer constructions will employ best management practices that reduce and mitigate disturbance to streambeds; or will be crossed using horizontal directional drilling (HDD) under the stream channel.

3. Transportation infrastructure will include a port on the Kuskokwim River and a road connecting the port to the mine facilities. Transportation operations will include increased barge activity along the Kuskokwim River, barge handling activities at the port, and truck traffic from the port to the mine facilities. The mine access road will cross six streams used by Chinook, coho and chum salmon. All six streams will be crossed with span bridges, resulting in low effect. Activities associated with port construction, port operation, and barge navigation between the Port and Bethel, are judged to result in a low effect to EFH species. Potential impacts at the Port would primarily result from pile driving and propeller strikes. Barging may result in an increased potential for stranding juvenile salmon during smolt outmigration, however, analysis of the distribution and

habitat use by outmigrating salmon and predicted barge-induced wave heights indicates such impacts should be low.

The evaluation of impacts includes mitigation measures integrated into the facility design, construction schedule, and implementation of best management practices. Mitigation measures proposed to reduce effects of project construction include sediment control best management practices (BMPs), such as silt fences, sediment retention basins, cross bars and ditches, runoff interception and diversion, mulching and revegetating disturbed surfaces and soil stockpiles, and other techniques designed to reduce the intensity of surface runoff, erosion, and sediment loads in downstream drainages.

Mitigation of unavoidable habitat losses would be achieved through a series of compensatory habitat modifications including: 1) removal of an apparent migration blockage on the South Fork of Getmuna Creek, 2) reclaiming the Getmuna material site to provide fish-rearing and over-wintering habitat, and 3) removing channel blockages along Crooked Creek to re-establish spawning habitats lost to beaver dams.

ACRONYM LIST

% .... percent
AAC .... Alaska Administrative Code
ADEC............... Alaska Department of Environmental Conservation
ADF .... Average Daily Flow
ADFG............... Alaska Department of Fish and Game
Amsl................. Above mean sea level
APDES............. Alaska Pollutant Discharge Elimination System
AWC .... Anadromous Waters Catalog
BPL .... Beluga Natural Gas Pipeline
Calista .... Corporation
cfs..................... cubic feet per second
CWA .... Clean Water Act
Donlin Gold ..... Donlin Gold, LLC
EEZ .... U.S. Exclusive Economic Zone (federal waters)
EFH.................. Essential Fish Habitat
EIS .... Environmental Impact Statement
FMP .... Fishery Management Plan
Ft .... foot or feet
HDD................. Horizontal Directional Drilling
HP .... Horsepower
km .... kilometer(s)
kmi^2 .... square kilometers
m .... meter(s)
m^3 .... cubic meters
m^3/sec............... cubic meters per second
mi .... statue mile(s)
mi^2 .... square miles
MP.................... Mile Post
MSFCMA .... Magnuson-Stevens Fishery Conservation and Management Act of 1996
NEPA .... National Environmental Policy Act
NMFS............... National Marine Fisheries Service
NOAA .... National Oceanic and Atmospheric Administration
ODPCP............. Oil Discharge Prevention and Contingency Plan
Project .... Donlin Gold Project
RHA .... Rivers and Harbors Act
ROW .... Right-of-Way
SFSGR .... Susitna Flats State Game Refuge
TKC .... The Kuskokwim Corporation
TSF................... Tailings Storage Facility
U.S. .... United States
USACE .... United States Army Corps of Engineers
USGS .... United States Geological Survey
WRF................. Waste Rock Facility
yd^3 .... cubic yards

1. PURPOSE AND SCOPE

This document presents the findings of an Essential Fish Habitat (EFH) assessment of the proposed Donlin Gold LLC (Donlin Gold) Mine Project (Project) in southwestern Alaska and is intended to support EFH consultation under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) of 1996. The MSFCMA, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), establishes procedures designated to identify, conserve, and enhance EFH for those species regulated under a federal Fishery Management Plan (FMP). Section 305(b)(2) of the MSFCMA requires federal agencies to consult with National Marine Fisheries Service (NMFS) on all actions or proposed actions authorized, funded, or undertaken by the agencies that might adversely affect EFH.

The EFH Guidelines, 50 Code of Federal Regulation (CFR) 600.05 – 600.930, outline procedures that federal agencies must follow to satisfy MSFCMA consultation requirements. Federal agencies must provide the NMFS with an EFH Assessment if the federal action may adversely affect EFH. An EFH assessment is to include the following contents (50 CFR 600.920(e)): 1) a description of the action, 2) an analysis of the potential effects of the action on EFH and managed species, 3) the federal agency's view of the effects of the action, and 4) proposed mitigation, if necessary.

In July 2012, Donlin Gold submitted a preliminary permit application, as per Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act (CWA), to the US Army Corps of Engineers (USACE) for the proposed Project. Updates to the permit application were submitted to the USACE in December 2014. Before making a decision on the application, the USACE is complying with the National Environmental Policy Act (NEPA) by developing an environmental impact statement (EIS) regarding the proposed Project. NMFS is not a formal cooperating agency in the NEPA process, but has been provided the same materials as cooperating agencies (e.g., preliminary versions of the EIS). Much of the information in this EFH Assessment has been drawn from the draft EIS.

The Project has the potential to adversely affect EFH, which requires the USACE to consult with NMFS under the MSFCMA. This EFH assessment was prepared following the MSFCMA regulations and EFH Assessment Guidance developed by the National Oceanic and Atmospheric Administration (NOAA) (2004).

The evaluation focuses on Pacific salmon (Chinook, chum, coho, pink and sockeye) as defined in the FMP for the Salmon Fisheries in the Exclusive Economic Zone (EEZ) off the Coast of Alaska (NPFMC et al. 2012). Transport of Project materials to and from the mouth of the Kuskokwim River will cross areas covered by other FMPs that deal with fisheries of the Pacific Northwest, Gulf of Alaska, and Bering Sea regions: however, ocean transport of material to support Project activities is unlikely to interfere with fisheries or fish populations in these regions since ocean transport is not identified as an activity of concern by NMFS (2011).

2. DEFINITION OF ESSENTIAL FISH HABITAT

EFH is defined as waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (50 CFR Part 600). For the purposes of this definition:

- "waters" means aquatic areas and their associated physical, chemical, and biological properties
- "substrate" includes sediment, hard bottom, structures underlying the water surfaces, and associated biological communities
- "necessary" means the habitat required to support a sustainable fishery and healthy ecosystem
- "spawning, feeding, and breeding" are terms used to encompass the complete life cycle of a species (50 CFR Part 600).

EFH is designated based on the best available scientific information and the levels defined by the MSFCMA including the following levels and corresponding information (NMFS, 2005):

- Level 1 - distribution
- Level 2 - density or relative abundance
- Level 3 - growth, reproduction, or survival rates
- Level 4 - production rates.

Pacific salmon EFH is designated for all species and all life stages based on Level 1 information (NMFS, 2005).

3. PROJECT DESCRIPTION

The EFH Assessment addresses the Project description that is the basis for the CWA 404/RHA 10 Preliminary Permit Application, which is equivalent to the proposed action in the USACE Donlin Gold Project EIS. Donlin Gold proposes to develop an open pit, hardrock gold mine on land leased from The Kuskokwim Corporation (TKC) and Calista Corporation (Calista). The proposed mine site is 277 mi (446 kilometers [km]) west of Anchorage, 145 mi (233 km) northeast of Bethel, and 10 mi (16 km) north of the village of Crooked Creek (**Figure 3.0-1**). Donlin Gold would construct the mine over three to four years and anticipates an active mine life of approximately 27.5 years of year-round operation (SRK Consulting, 2012). Reclamation and closure have been integrated into the project design and would occur over four years. Following reclamation and closure, post-closure management and treatment of water would continue.

The Project has three primary components: 1) mine site facilities, 2) natural gas pipeline, and 3) transportation infrastructure including an airstrip, port on the Kuskokwim River at Jungjuk Creek (Jungjuk Port, or Port), and a 30-mi (48-km) gravel mine access road to connect the port and the mine site.

These components are described below and in greater detail in the EIS (Section 2.3.2 Alternative 2 – Donlin Gold's Proposed Action) as well as SRK (2012) (portions of which are being updated) and SRK (2013).

3.1. Mine Site Facilities

The mine site facilities would be within the Crooked Creek drainage at elevations ranging from 500 feet (ft) above mean sea level (amsl) (152 m amsl) to 2,100 ft amsl (640 m amsl) on the western slopes of the Kuskokwim Mountains. The Crooked Creek drainage encompasses approximately 333 square mi (mi^2) (862 sq km [km^2]), flowing into the Kuskokwim River at the village of Crooked Creek (**Figure 3.0-1**).

Major Project components would be constructed in American Creek, Anaconda Creek, and Snow Gulch basins. The American and Anaconda basins comprise approximately 7 mi^2 (18 km^2). The mine pit and waste rock facility (WRF) would be within the American Creek drainage. The tailings storage facility (TSF) would be in the Anaconda Creek drainage. Tailings storage would encompass 2,351 acres (951 hectares) with a 464-ft (141-m) high (above existing ground level) dam constructed at the downstream location. Snow Gulch basin, with a catchment area of approximately 2.4 mi^2 (6.2 km^2), would include a freshwater reservoir to supply freshwater needed for the Project.

Key on-site mine components would include an open pit mine, TSF, WRF, mill, power plant, bulk fuel storage (with secondary containment), material source and storage sites, freshwater reservoirs, contact water ponds, personnel camps, water treatment plant, and connecting road infrastructure. Two temporary freshwater diversion dams would be used to minimize runoff to the impoundment and facilitate construction of the TSF dam.

3.2. Natural Gas Pipeline

To meet the energy needs of the Project, Donlin Gold has proposed a natural gas-fired power plant fed by a 315-mi (507-km) 14-inch (36-centimeters [cm]) diameter, buried, natural gas pipeline (**Figure 3.2-1**). The proposed pipeline route crosses an area with no significant pre-existing infrastructure and does not follow any existing utility right-of-way (ROW).

The pipeline would originate at a tie-in near Beluga on Cook Inlet and would terminate at the mine site. The pipeline route would begin at the Beluga Natural Gas Pipeline (BPL), designated Mile Post (MP) MP 0 within the Susitna Flats State Game Refuge (SFSGR) and follow the Pretty Creek public road easement through most of the pipeline route though the SFSGR. The pipeline would receive booster compression supplied by one compressor station at approximately MP 0.4, near the beginning of the pipeline, inside the boundary of the SFSGR. From the SFSGR, the proposed route proceeds northerly, traversing the east flank of Little Mount Susitna to the Skwentna River (approximately MP 50), then parallels the Skwentna River westerly to Puntilla Lake (approximately MP 102).

From approximately MP 106 the route trends northwesterly to a crossing of Happy River at approximately MP 108.5. From the Happy River crossing, the pipeline route proceeds along a low moraine ridge before turning north into the broad valley of Threemile Creek. At approximately MP 114.5, the alignment trends westerly as it approaches an unnamed pass in the Alaska Range divide. This pass has an elevation of 3,870 ft amsl (1,180 m amsl). Short, steep drainages immediately on each side of the pass are in narrow valleys with talus lobes and stabilized rock glaciers at the base of steep rock slopes. At approximately MP 120.5, the pipeline route enters a typical broad U-shaped (i.e., glacial) valley. As the pipeline route descends this valley it trends along the benches or terraces with moderate to little slope that border this unnamed tributary of the Tatina River.

At approximately MP 127.3, the proposed route crosses the Tatina River braided glacial outwash floodplain before it ascends to a broad open pass and then descends into the Jones River valley at approximately MP 130.5. From approximately MP 130.5 to MP 143 the pipeline route remains in the Jones River valley and roughly parallels the Jones River. The route crosses the Jones River twice, at approximately MP 136.6 and MP 137.6. The pipeline route exits the mountains to the west of the Alaska Range at approximately MP 143, then trends westerly across the south fork of the Kuskokwim River and then southwesterly toward Farewell, Alaska.

The proposed route continues southwesterly near Farewell (approximately MP 157), paralleling the Alaska Range until crossing the Kuskokwim River (between approximately MP 240 and MP 241). Beyond the Kuskokwim River, the route primarily follows ridgelines west for more than 80 mi (129 km), to the terminus at the proposed mine site about 10 mi (16 km) north of the village of Crooked Creek.

The pipeline would be buried in trenches, except for six crossings where horizontal directional drilling (HDD) will be used. At trenched crossings, a trench would be excavated using chain excavators, wheel trenchers, and/or backhoes. Trenching crews would excavate a trench deep enough to provide the design soil cover depth over the top of the pipe. Construction and water diversion methods used to excavate the trench would vary, depending on soil type and terrain characteristics. Excavators would generally be used in areas of steep slopes, high water table, soils with cobbles and boulders, or deep trench areas such as river and stream crossings.

3.3. Transportation Facilities

This section describes the proposed transportation facilities and cargo/fuel transport and storage associated with the Kuskokwim River.

Transportation facilities included in the proposed Project are:

- Mine access road
- Jungjuk Port
- Airstrip near the mine site

Each of these facilities is described in Section 3.3.1 through Section 3.3.3.

3.3.1. Mine Access Road

The 30-mi (48 km) access road connecting the Jungjuk Port site and the mine site would be a two-lane, all-season gravel road, designed to accommodate seasonal drainage and spring runoff and would be used to move fuel and cargo between the port and mine site during the 110-day navigation season. The completed road would include six bridge crossings of anadromous fish-bearing streams. Short spur roads off the main access road would connect to the mine site airstrip and mine camp facilities.

Construction materials for the access road and facilities would be excavated from 13 material sites. The largest of the material sites (material site [MS] 10) would be located just upstream from the confluence of the north and south forks of Getmuna Creek, the largest tributary in the Crooked Creek drainage at 98.6 mi^2 (255 km^2).

3.3.2. Jungjuk Port Site

The Jungjuk Port site, located on the Kuskokwim River 9 miles (14.5 km) downstream of the Village of Crooked Creek, would include a container unloading and storage area with sufficient space to hold up to 1,000 containers. A sheet pile bulkhead earth-retaining system would be used for protection of the dock against ice loading. The dock at the Jungjuk Port would be approximately 4.4 acres (1.8 hectares) and would be constructed above the high water line.

3.3.3. Airstrip Near Mine Site

An airstrip would be constructed to support transport of personnel to the mine as well as some perishable and emergency re-supply cargoes. The airstrip would be approximately 9 mi (14 km) by road west of the mine site. It would be accessed by a 3- mi (4.8- km) spur road beginning at the Donlin-Jungjuk Road (**Figure 3.0-1**). The airstrip would be gravel surface, 5,000 ft (1,524 m) long and 150 ft (46 m) wide. The airstrip would be constructed along a ridge that aligns with the prevailing winds from the southeast. The spur road route follows high terrain and does not cross any permanent streams.

3.3.4. Cargo and Fuel Transportation Handling

General

Cargo for Project operations would be transported from terminals in Seattle, Washington (WA); Vancouver, British Columbia (BC); or Dutch Harbor, Alaska via marine barge to Bethel, 73 river miles (117 km) upstream on the Kuskokwim River. At Bethel, it is expected that cargo would be transferred to the dock for temporary storage or loaded directly onto river barges for transport up the Kuskokwim River to Jungjuk Port, approximately 177 river miles (284 km) upstream of Bethel (**Figure 3.3-1**). During the shipping season, containerized, break-bulk, and other general cargoes would be transported from Jungjuk Port to the mine by a fleet of B-train tractor-trailer units.

Barging of cargo from the west coast ports would occur between May and September when all waters are clear of ice, and seasonal storms have abated. Barging would occur over the estimated three to four years of mine construction and 27.5 years of operation. During mine operation, three sets of cargo barges departing from Seattle or Vancouver would make approximately 12 round trips (24 transits) annually to Bethel, each round-trip is expected to take about 32 days (**Table 3.3-1**). Each barge would have a deadweight capacity of 11,500 short tons (10,433 tonnes) and a net cargo capacity of 9,480 short tons (8,600 tonnes), and would be hawser-towed by a 4,200-horsepower (HP) oceanic tugboat. Cargo would include annual consumables and general cargo consolidated as bulk in containers, bulk in super-sacks, loose, or palletized break-bulk, small packages, and liquid in small tanks.

Table 3.3-1: Estimated Annual Ocean and River Barge Traffic

Material	From	To	Number of Round Trips per Season
Cargo	Seattle, WA or Vancouver, BC	Bethel	16 during construction 12 during operation
Fuel	Dutch Harbor	Bethel	14
Pipe and Equipment	Bethel	Kuskokwim Landing	20 during first two years of pipeline construction
Pipe and Equipment	Anchorage	Beluga Landing	20 during first year of pipeline construction
Cargo	Bethel	Jungjuk Port	50 during construction[1] 64 during operation
Fuel	Bethel	Jungjuk Port	19 during construction[2] 58 during operation

Notes:

1 Total would be 200 trips over four years of construction. Exact distribution (number of round trips each year) would be determined during final design.

2 Number is an average, the actual number would range from 9 to 29 depending on the year.

Source: SRK (2013a)

Fuel

During mine operation, fuel would be transported from Dutch Harbor to Bethel using a single double-hulled barge with capacity of up to 2.9 million U.S. gallons (10.98 million liters). The barge would be towed by a 3,000-HP tugboat. At Bethel, fuel would either be transferred directly to double-hulled fuel river barges for transport to Jungjuk Port, or off-loaded for temporary storage and later transported to Jungjuk Port. From Jungjuk Port, fuel would be transported to the mine site fuel storage facility via B-train tanker trucks on the mine access road (Section 3.3.1).

Fuel demand will vary over the mine life, but at the peak of operation a maximum of about 14 barge trips per year across Kuskokwim Bay would be required.

River Transport

From the Bering Sea, a navigation channel on Kuskokwim Bay and upstream to Bethel is marked by seasonal buoys. The marked channel is known to shift from time to time due to river currents on the sandy river bottom. Local tug and barge operators would depart Bethel for Jungjuk Port once Bethel is clear of ice and flow levels provide at least 2 ft (60 cm) of gross under the keel clearance, when factoring stream flow and barge loads (Amec, 2014).

Barge traffic from Bethel to Jungjuk Port would consist of multiple, daily, 24-hour operation, four-barge tows over the estimated 110-day shipping season from approximately June 1 to September 9. River barge shipments throughout the mine life between Bethel and Jungjuk Port site would range from approximately 122 to 190 cargo and fuel barge tows (round trips) per season. Diesel fuel would be transported to the Jungjuk Port site every four days.

For construction of the natural gas pipeline, it is estimated that up to 20 annual barge trips, over two years will be required to transport gas line pipe and other pipeline construction supplies to the Kuskokwim barge landing site (near the Kuskokwim River and proposed natural gas pipeline intersection) (**Table 3.3-1)**. Up to 20 construction barge trips (40 transits) will run from Anchorage to Beluga (at a beach landing site). All trips would occur within one construction season with gas line pipe as the primary cargo. The beach landing site is 3.8 mi (6.1 km) south of the Beluga Airport and 7.3 mi (11.7 km) south of the mouth of the Beluga River.

4. EVALUATION OF POTENTIAL IMPACTS TO EFH

4.1. Species Evaluated

The proposed Project would be within the jurisdiction of the FMP for the Salmon Fisheries in the EEZ off Alaska (NPFMC et al., 2012), which lists five species of Pacific salmon that could occur within the Project Area: Chinook, sockeye, coho, chum, and pink salmon.

Pacific salmon populations within the Project Area are all in the West Management Area, which includes all federal waters west of Cape Suckling in the Gulf of Alaska to Demarcation Point in the Beaufort Sea; with the exception of three excluded areas in northern Gulf of Alaska. Pacific salmon EFH in Alaska is designated based on Level 1 (i.e., information based on distribution) (NMFS, 2005). The Salmon FMP identifies EFH for each species' life stage and, in most cases, is based on either the general distribution of the life stage or the general distribution of the life stage in waters identified by the Alaska Department of Fish & Game (ADF&G) Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes (Johnson and Coleman, 2014a and 2014b).

Pacific salmon are the species of interest within the Project Area and any fishery based on these species could potentially be affected by Project activities. Life stages expected to be exposed to proposed Project activities include: freshwater eggs, freshwater larvae and juveniles, and freshwater adults (**Table 4.1-1**).

Table 4.1-1: Salmon Species EFH Life Stages Present in the Project Area

Salmon Species	Freshwater Eggs	Freshwater Larvae and Juveniles	Estuarine Juveniles	Marine Juveniles	Marine Immature and Maturing Adults	Freshwater Adults
Chinook	1	1	2	2	2	1
Sockeye	1	1	2	2	2	1
Coho	1	1	2	2	2	1
Chum	1	1	2	2	2	1
Pink	1	1	2	2	2	1

1 = life stage with defined EFH in the Project Area.
2 = life stage with defined EFH, but none in the Project Area.
Source: NMFS (2005)

4.2. EFH within the Project Area

The EFH life stages for salmon within the Project Area include maturing and spawning adults, incubating eggs, rearing juveniles, and outmigrating juveniles. The following sections address EFH by Project components: mine site facilities, natural gas pipeline, and transportation facilities.

4.2.1. Mine Site Facilities

Based on studies by OtterTail Environmental (OtterTail) (2014a), all five Pacific salmon species are present in or near the proposed mine site area (**Table 4.2-1**) as either adult or juvenile stages. Nine of the 18 surveyed streams represent EFH. Snow Gulch is not considered to represent EFH because only a few adult coho salmon were observed in the lower reach near the mouth of the creek; these fish were likely resting on their way to spawning areas in another stream.

Table 4.2-1: Pacific Salmon Identified within the Crooked Creek Drainage (2004-2013)

		Chinook		Coho		Sockeye		Chum	Pink
Stream	**EFH Stream**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Adult**
Donlin Creek	Yes	--	--	--	+	--	--	+	--
Flat Creek	Yes	--	--	--	+	--	--	--	--
Dome Creek	Yes	--	--	--	+	--	--	--	--
Quartz Creek	No	--	--	--	--	--	--	--	--
Snow Gulch	No	--	--	+[1]	--	--	--	--	--
Queen Gulch	No	--	--	--	--	--	--	--	--
Crooked Creek	Yes	+	+	+	+	+	+	+	+
Lewis Gulch	No	--	--	--	--	--	--	--	--
American Creek	Yes	--	--	--	+	--	--	--	--
Grouse Creek	Yes	--	--	+	--	--	--	--	--
Omega Gulch	No	--	--	--	--	--	--	--	--
Anaconda Creek	Yes	--	--	--	+	--	--	--	--
Crevice Creek	No	--	--	--	--	--	--	--	--
Eagle Creek	No	--	--	--	--	--	--	--	--
BC Creek	No	--	--	--	--	--	--	--	--
AC Creek	No	--	--	--	--	--	--	--	--
Getmuna Creek	Yes	+	+	--	+	+	+	+	--
Bell Creek	Yes	--	+	--	+	--	--	+	--

+ = Present; -- = Not Detected

[1] Adult coho salmon have been observed in Snow Gulch, but all were just upstream of the stream mouth and were likely associated with Crooked Creek.

Source: OtterTail (2014a)

Adult salmon are present in Crooked Creek, both downstream and upstream from the proposed mine site (**Figure 4.2-1**). Chinook, coho, and chum salmon are consistently present, with sockeye and pink salmon occurring in lower numbers (**Table 4.2-2**). Adult salmon enter Crooked Creek drainage from late June until late September, depending on species, beginning with Chinook and ending with coho (**Figure 4.2-2**).

Table 4.2-2: Crooked Creek Weir Salmon Escapement Summary, 2008 to 2012

(estimated total numbers corrected for periods when weir was inoperable)

Species	2008	2009	2010	2011	2012
Chinook Salmon	86	100	49	32	29
Chum Salmon	1,699	1,991	1,257	3,755	832
Coho Salmon	4,204	1,295	1,212	591	868
Pink Salmon	11	59	5	4	19
Sockeye Salmon	60	10	5	16	1
Totals	6,060	3,455	2,528	4,398	1,749

Source: OtterTail (2014a)

Based on summer aerial surveys between 2004 and 2013, 77 percent (%) of the Chinook salmon adults within the Crooked Creek mainstem were in reaches downstream from the mine area, while 95% of the chum salmon were in downstream reaches (**Table 4.2-3**). Conversely, 70% of coho salmon adults observed in Crooked Creek during fall surveys were in stream reaches adjacent to the mine area (**Table 4.2-3**).

On average, 170 redds are documented each year in the Crooked Creek watershed during summer redd surveys (OtterTail, 2014a). Although redds were not associated with a specific salmon species, Chinook and chum salmon are the most abundant species present during summer surveys. Summer redds tended to be more abundant in the lower watershed, with 95% of summer redds found in the mainstem of Crooked Creek occurring in the lower reaches, approximately 3 mi (4.8 km) downstream from Anaconda Creek to the Kuskokwim River (**Table 4.2-4**). A similar trend was noted in Getmuna Creek, with 93% of redds documented in Getmuna Creek occurring in the lower reach. Adult salmon aerial counts also show Chinook and chum salmon preferences toward these lower reaches.

Fall redd surveys have documented a five-year average of 288 redds in the Crooked Creek watershed (Ottertail, 2014a). Although redds were not associated with a specific salmon species, adult salmon aerial surveys showed coho salmon to be the most abundant species present during fall surveys. Fall redd surveys show the tendency of coho salmon to spawn higher in the watershed and in tributaries. On average, the Crooked Creek tributaries Donlin Creek, Getmuna Creek, and Bell Creek accounted for 20%, 25% and 20% of all fall redds, respectively. Mainstem reaches of Crooked Creek adjacent to the mine area contained 27% of fall redds. Redds have been documented as high up in the watershed as upper Donlin Creek, upper Getmuna Creek, and upper Bell Creek (**Figure 4.2-1**).

Juvenile Chinook rear in Crooked and Getmuna Creeks, with some indication of rearing in Bell Creek (**Table 4.2-5**). Coho salmon juveniles were more widely distributed, being found in eight creeks and at higher densities than Chinook salmon (**Figure 4.2-3**). Sockeye salmon juveniles were occasionally encountered (**Table 4.2-5**). Juvenile chum salmon outmigrate shortly after emergence from the gravel, so were not found during studies of rearing salmon.

Table 4.2-3: Distribution of Pacific Salmon in Crooked Creek Based on Aerial Surveys, 2004 to 2013.

Table 4.2-3			Crooked Creek Reaches[1]					
			Adjacent to Mine Area			Downstream of Mine Area		
Season	Species	Year	Donlin to American	American to Anaconda	Anaconda to Eagle	Eagle to Bell	Bell to Kuskokwim	Crooked Creek Total
Summer	**Chinook**	**2004**	0	2	4	20	29	55
		2005	6	2	0	6	1	15
		2006	0	1	1	5	5	12
		2007	0	1	1	2	0	4
		2008	0	0	0	2	1	3
		2009	0	3	3	6	10	22
		2010	0	0	0	0	0	0
		2011	0	0	0	1	5	6
		2012	0	0	2	1	5	8
		2013	0	0	4	3	0	7
		Mean[2]	0.6	0.9	1.5	4.6	5.6	13.2
		Min	0	0	0	0	0	0
		Max	6	3	4	20	29	55
	Chum	**2004**	0	1	3	134	52	190
		2005	7	15	24	178	291	515
		2006	0	0	1	146	280	427
		2007	8	17	21	89	264	399
		2008	0	0	1	30	16	47
		2009	2	10	4	72	77	165
		2010	0	2	3	37	66	108
		2011	0	0	4	177	212	393
		2012	0	0	1	124	109	234
		2013	2	12	4	333	243	594
		Mean[2]	1.9	5.7	6.6	132	161	307.2
		Min	0	0	1	30	16	47
		Max	8	17	24	333	291	594

Table 4.2-3			Crooked Creek Reaches[1]					
			Adjacent to Mine Area			Downstream of Mine Area		
Season	Species	Year	Donlin to American	American to Anaconda	Anaconda to Eagle	Eagle to Bell	Bell to Kuskokwim	Crooked Creek Total
	Sockeye	2004	0	0	0	0	0	0
		2005	0	0	0	0	0	0
		2006	0	0	0	0	0	0
		2007	0	0	0	0	0	0
		2008	0	0	0	0	0	0
		2009	0	0	0	0	0	0
		2010	0	0	0	0	0	0
		2011	0	0	0	0	3	3
		2012	0	0	0	0	0	0
		2013	0	0	0	0	0	0
		Mean[2]	0	0	0	0	0.3	0.3
		Min	0	0	0	0	0	0
		Max	0	0	0	0	3	3
	Pink salmon	2004	0	0	0	0	0	0
		2005	0	0	0	0	0	0
		2006	0	0	0	0	0	0
		2007	0	0	0	0	0	0
		2008	0	0	0	0	0	0
		2009	0	0	0	0	0	0
		2010	0	0	0	0	0	0
		2011	0	0	0	0	0	0
		2012	0	0	0	0	0	0
		2013	0	0	0	1	0	1
		Mean[2]	0	0	0	0.1	0	0.1
		Min	0	0	0	0	0	0
		Max	0	0	0	1	0	1

Table 4.2-3			Crooked Creek Reaches[1]					
			Adjacent to Mine Area			Downstream of Mine Area		
Season	**Species**	**Year**	Donlin to American	American to Anaconda	Anaconda to Eagle	Eagle to Bell	Bell to Kuskokwim	**Crooked Creek Total**
Fall	**Coho**	**2004**	27	23	9	3	2	64
		2005	1	0	0	0	0	1
		2006	0	0	0	0	0	0
		2007	0	7	8	0	0	15
		2008	24	38	25	18	14	119
		2009	8	3	15	40	7	73
		2010	35	5	4	22	8	74
		2011	39	36	19	26	3	123
		2012	1	ns	ns	ns	ns	1
		2013	2	0	0	0	0	2
		Mean[2]	13.7	12.4	8.9	12.1	3.8	47.2
		Min	0	0	0	0	0	0
		Max	39	38	25	40	14	123
	Pink	**2004**	0	0	0	0	0	0
		2005	0	0	0	0	0	0
		2006	0	0	0	0	0	0
		2007	0	0	0	0	0	0
		2008	0	0	0	0	0	0
		2009	0	0	0	0	0	0
		2010	0	0	0	0	0	0
		2011	0	0	0	0	1	1
		2012	0	ns	ns	ns	ns	0
		2013	0	0	0	0	0	0
		Mean[2]	0	0	0	0	0.1	0.1
		Min	0	0	0	0	0	0
		Max	0	0	0	0	1	1

[1] see Figure 4.2-1

[2] Mean = (total fish seen/number of years surveyed)

ns = not surveyed

Source: OtterTail (2014a)

Table 4.2-4: Aerial Counts of Salmon Redds within Crooked Creek Mainstem (2009-2013)

Season	Stream	Reach	2009	2010	2011	2012	2013	Total
Summer	Crooked Creek	Donlin to American						0
		American to Anaconda			3		3	6
		Anaconda to Eagle		6	2	1	3	12
		Eagle to Bell		20	43	21	97	181
		Bell to Kuskokwim		50	44	29	59	182
Summer Total			0	76	92	51	162	**381**
Fall	Crooked Creek	Donlin to American	6	3	13			22
		American to Anaconda	6	1	23			30
		Anaconda to Eagle	29	2	18			49
		Eagle to Bell	97	19	10			126
		Bell to Kuskokwim	101	16	23			140
Fall Total			239	41	87	0	0	**367**
Grand Total			239	117	179	51	162	**748**

Shaded reaches are adjacent to the mine area, other reaches are downstream

Summer redds are mostly chum with some chinook; Fall redds are mostly coho salmon

Source: OtterTail (2014a)

Table 4.2-5: Summary of Electrofishing Results by Site within the Crooked Creek Drainage (2004-2013)

			Average # Fish Captured[1] (#/300 ft)		
Streams	**Site**	***n* (years)**	**Chinook salmon (Juvenile)** **Mean** Range	**Coho salmon (Juvenile)** **Mean** Range	**Sockeye salmon (Juvenile)** **Mean** Range
Donlin Creek	DO1	9	--	**36.3** (2-182)	--
Flat Creek	FL1	6	--	**1.6** (0-3.1)	--
Dome Creek	DM1	2	--	**28.0** (0-56.1)	--
Quartz Creek	QZ1	1	--	--	--
Snow Gulch	SN1	1	--	--	--
	SN2	7	--	--	--
Queen Gulch	QU1	1	--	--	--
Crooked Creek	CR2	9	**2.0** (0-7.6)	**18.3** (3-70.1)	--
	CR1	9	**2.1** (0-10.9)	**110.0** (1.6-831.6)	--
	CR0.7	7	**2.1** (0-8.5)	**35.9** (6.4-195.7)	**3.6** (0-23.4)
	CR0.3	5	**5.5** (0-22.7)	**11.8** (1.5-45.5)	--
Lewis Gulch	LE1	1	--	--	--
American Creek	AM1	7	--	**6.0** (0-18.3)	--
	AM2	1	--	--	--
	AM3	1	--	--	--
	AM4	2	--	--	--
Grouse Creek	GR1	1	--	--	--
Omega Gulch	OM1	1	--	--	--
Anaconda Creek	AN1	7	--	**0.1** (0-1)	--
	AN2	4	--	--	--
Crevice Creek	CV1	4	--	--	--
Eagle Creek	EG1	1	--	--	--
BC Creek	BC1	1	--	--	--
AC Creek	AC1	1	--	--	--
Getmuna Creek	GM1	3	**12.0** (6-21.6)	**90.8** (15.6-231.6)	**0.8** (0-2.4)
	GM2	1	--	**16.0** NA	--
	GM3	2	--	**20.5** (10-31)	--
	GM4	1	--	**9.0** NA	--
Bell Creek	BL1	2	**0.5** (1-1)	**6.0** (4-8)	--

Refer to **Figure 4.2-2** for site locations.
Adult salmon are not included in the above counts.
1) #/300 ft = number of fish per 300 feet. Only one pass was allowed in 2005 & 2006; therefore, one pass data were used for each year in this table to enable comparison between years.
NA = no range available for 1 year of sampling
Source: OtterTail (2014a)

4.2.2 Natural Gas Pipeline

The proposed 315-mi (507-km) buried natural gas pipeline would cross numerous tributaries to salmon-producing drainages. OtterTail (2014b) conducted an evaluation of each stream crossing, including field sampling at sites not previously identified by ADF&G as containing anadromous fish. Drainages were surveyed on the ground if they met the following criteria: 1) the drainage was deemed to have potential for fish occurrence; 2) the crossing was not cataloged anadromous in the ADF&G (2011) Anadromous Waters Catalog (AWC); and 3) the stream crossing was not planned to be accomplished by HDD.

Between 2010 and 2014, a total of 1,053 sampling site visits to 672 sampling sites were conducted, with over 25 mi (40 km) of stream electrofished during the survey. Through 2014, 77 anadromous crossings were identified (**Figure 4.2-4, Table 4.2-6**). Green shading within the table indicates stream crossings to be constructed during summer; the others will be constructed during winter. A complete list of all sampling results from proposed crossings, including maps of each crossing, is presented in the Aquatics Map Book (OtterTail 2014c).

Drainages and streams identified as particularly important to salmon and crossed by the proposed natural gas pipeline include the Lewis River, Wolverine and Sucker creeks. The Lewis River has historically supported Chinook and coho salmon fisheries. Chinook salmon in this area are now recognized by the ADF&G Board of Fish as a stock of concern. Wolverine and Sucker Creeks (below the confluence with Wolverine Creek) provide more than 90% of the spawning habitat for Chinook salmon in the Alexander Creek drainage. Spawning habitat in upper Wolverine Creek would be considered important and sensitive when considering method of crossing or establishment and operation of a nearby construction camp.

The Skwentna River is a corridor for anadromous fish migration for the five species of Pacific salmon. The main channel is known to provide spawning habitat for sockeye, chum, and coho salmon. The main channel likely provides some rearing habitat for juvenile salmon as well. Within the Skwentna drainage, Eightmile Creek supports a relatively small Chinook and coho salmon fishery at its confluence with the Skwentna River. Eightmile Creek provides spawning habitat for Chinook salmon. Shell Lake is one of two major sockeye salmon-producing lakes within the Yentna River drainage in the Susitna basin. Susitna River sockeye salmon are a recognized stock of concern by the Board of Fish. Though most of the sockeye salmon production occurs well upstream of the proposed pipeline crossing, lower Shell Creek provides habitat for spawning and rearing coho salmon. The Happy River drainage supports spawning and rearing sockeye salmon, most notably in Puntilla Lake from where Squaw Creek drains. Chinook salmon spawning and rearing occurs on the lower 1.5 mi (2.4 km) of Squaw and Indian Creeks. Chinook salmon production in the Happy River drainage contributes to downstream fisheries on the Skwentna and Yentna Rivers.

The George and Tatlawiksuk Rivers have weirs that have continually collected escapement data since the late 1990s. Their operational period is between June 15 and September 20. In most years, all five species of Pacific salmon pass the weir in both rivers, with chum and coho salmon the most abundant (Brazil et al., 2013).

Table 4.2-6: EFH Stream Crossings along the Natural Gas Pipeline Route

Drainage	Mainstem	Tributary	Sub Trib	Mile Post	Crossing[1]	Sample Site[2]	Year Sampled[3]	Species	Chinook Salmon[4]	Chum Salmon	Coho Salmon	Sockeye Salmon
Cook Inlet	Theodore R.	***Mainstem***		5.36	cTH1	cTH1	2014	CO	0	0	8	0
		Tribs		0.48	cTHT89	cTHT89	2014	CO	0	0	20	0
				1.65	cTHT91	cTHT91_OH1	2013	K,CO	8	0	1	0
							2014	CO	0	0	51	0
				2.08	cTHT91.5	cTHT91.5	2014	CO	0	0	2	0
	Lewis R.	***Tribs***		15.32	cLET3	cLET3_OH1	2010	CO	0	0	37	0
						cLET3_OH2	2010	CO	0	0	10	0
				15.58	cLET4	cLET4_OH1	2010	CO	0	0	35	0
				6.28	cLET76	cLET76_OH1	2011	CO	0	0	11	0
				6.69	cLET77	cLET77_OH1	2011	CO	0	0	2	0
						cLET77_OH2	2010	CO	0	0	11	0
							2011	CO	0	0	11	0
	Alexander Ck	***Bear Ck***	Mainstem	32.86	**cBE1**	cBE1		•	--	--	--	--
Skwentna	Skwentna R.	***Mainstem***		50.21	**sSK1**	sSK1		•	--	--	--	--
	Eightmile Cr.	***Mainstem***		44.81	**sEI1**	sEI1		•	--	--	--	--
		Tribs		44.11	sEIT2	sEIT2	2010	CO	0	0	98	0
							2011	CO	0	0	25	0
						sEIT2_OH1	2010	CO	0	0	108	0
				44.24	sEIT3	sEIT3	2010	CO	0	0	1	0
	Shell Cr.	***Mainstem***		53.30	**sSL1**	sSL1		•	--	--	--	--
		Tribs		53.25	sSLT1	sSLT1	2010	CO	0	0	83	0
	Happy R.	***Mainstem***		86.05	**sHA1**	sHA1		•	--	--	--	--
				108.44	**SHA3**	sHA3		•	--	--	--	--
		Canyon Cr.	Mainstem	95.18	**sCA1**	sCA1		•	--	--	--	--
		Indian Cr.	Mainstem	102.69	**sIN1**	sIN1		•	--	--	--	--
		Squaw Cr.	Mainstem	100.71	**sSQ2**	sSQ2		•	--	--	--	--
	Tribs			59.42	sSKT8	sSKT8	2010	CH,CO	0	3	69	0
							2011	CO	0	0	42	0
				66.28	**sSKT13**	sSKT13		•	--	--	--	--
				67.38	**sSKT14**	sSKT14		•	--	--	--	--
				68.14	**sSKT15**	sSKT15		•	--	--	--	--
				70.52	sSKT17	sSKT17_OH2	2010	CO	0	0	10	0
				73.11	sSKT19	sSKT19_OH1	2010	K,CO	1	0	16	0
				75.25	sSKT21	sSKT21_OH1	2010	CO	0	0	3	0
				84.02	sSKT27	sSKT27_OH1	2010	K	2	0	0	0
				71.60	sSKT28	sSKT28	2011	CO	0	0	1	0
				62.91	sSKT30	sSKT30	2010	CO	0	0	2	0
							2011	CO	0	0	40	0
				61.76	sSKT36	sSKT36	2010	CO	0	0	68	0
							2011	CO	0	0	2	0
				64.15	sSKT40	sSKT40	2010	CO	0	0	15	0
							2011	CO	0	0	5	0

Table 4.2-6

Drainage	Mainstem	Tributary	Sub Trib	Mile Post	Crossing[1]	Sample Site[2]	Year Sampled[3]	Species	Chinook Salmon[4]	Chum Salmon	Coho Salmon	Sockeye Salmon
Skwentna	**Tribs**			64.59	sSKT41	sSKT41	2010	CO	0	0	12	0
Skwentna	**Tribs**			64.59	sSKT41	sSKT41	2011	CO	0	0	6	0
				74.68	sSKT45	sSKT45	2010	CO	0	0	1	0
						sSKT45_OH1	2010	K,CO,S	4	0	40	7
				61.63	DR11	DR11	2011	CO	0	0	13	0
Yentna		***Johnson Cr.***	**Red Cr.A**	78.65	yRET1	yRET1_OH1	2010	CO	0	0	24	0
Kuskokwim	**S.F. Kuskokwim R.**	***Mainstem***		146.49	**kSF4**	kSF4		•	--	--	--	--
		Side Arm		147.22	**kSFT60**	kSFT60		•	--	--	--	--
				146.03	kSFT72	kSFT72	2012	Ø	0	0	0	0
		Tatina R.	**Mainstem**	127.25	kTA2	kTA2_OH10	2010	CO	0	0	3	0
						kTA2_OH4	2011	CO	0	0	5	0
						KTA2_OH5	2010	CO	0	0	8	0
						kTA2_OH6	2010	CO	0	0	14	0
							2011	CO	0	0	8	0
						kTA2_OH8	2010	CO	0	0	14	0
						kTA2_OH9	2010	CO	0	0	9	0
		Tin Cr.	**Mainstem**	149.57	kTI2	kTI2	2013	CO	0	0	1	0
		Sheep Cr.	**Tribs**	145.43	kSFT73	kSFT73	2012	CO	0	0	2	0
							2013	CO	0	0	2	0
				145.01	kSFT75	kSFT75_OH1	2013	CO	0	0	1	0
	Windy F. Kuskokwim R.	***Mainstem***		168.06	kWI1	kWI1	2011	CO	0	0	4	0
						kWI1_OH2	2010	CO	0	0	43	0
						kWI1_OH3	2010	CO	0	0	3	0
	M.F. Kuskokwim R.	***Mainstem***		182.73	kMF1	kMF1_OH1	2011	CO	0	0	3	0
	Big R.	***Mainstem***		191.16	**kBI1**	kBI1		•	--	--	--	--
		Sidearm		191.49	**KBI2**	kBI2		•	--	--	--	--
				190.87	**kBIT11**	kBIT11		•	--	--	--	--
	Tatlawiksuk R.	***Mainstem***		217.38	**kTL1**	kTL1		•	--	--	--	--
		Sidearm		217.06	kTLT11	kTLT11	2011	CO	0	0	15	0
		Tribs		204.98	kTLT2	kTLT2	2010	K,CO	6	0	64	0
							2011	CO	0	0	25	0
				207.11	kTLT4	kTLT4_OH1	2010	CO	0	0	11	0
				211.18	kTLT6	kTLT6	2011	CO	0	0	1	0
				211.45	kTLT7	kTLT7	2010	CO	0	0	63	0
							2011	CO	0	0	29	0
				214.29	kTLT9	kTLT9	2012	CO	0	0	2	0
				216.08	**kTLT10**	kTLT10		•	--	--	--	--
				219.12	kTLT14	kTLT14	2012	CO	0	0	4	0
				221.21	kTLT16	kTLT16	2010	CO	0	0	4	0
							2011	CO	0	0	7	0
				227.30	kTLT21	kTLT21	2010	CO	0	0	4	0
							2011	CO	0	0	2	0
				231.66	**kTLT23**	kTLT23		•	--	--	--	--

Table 4.2-6

Drainage	Mainstem	Tributary	Sub Trib	Mile Post	Crossing[1]	Sample Site[2]	Year Sampled[3]	Species	Chinook Salmon[4]	Chum Salmon	Coho Salmon	Sockeye Salmon
Kuskokwim	**Tatlawiksuk R.**	***Tribs***		232.15	kTLT24	kTLT24	2010	CO	0	0	1	0
						kTLT24 OH1	2010	CO	0	0	2	0
				233.39	kTLT25	kTLT25 OH1	2010	CO	0	0	2	0
				218.85	kTLT29	kTLT29	2012	CO	0	0	6	0
				227.12	kTLT31	kTLT31	2010	CO	0	0	6	0
							2011	CO	0	0	3	0
				227.12	**kTLT31 awes**	kTLT31 awes		•	--	--	--	--
Kuskokwim	**Kuskokwim R.**	*Mainstem*		240.64	**kKU1**	kKu1		•	--	--	--	--
						kKu1_OH3	2012	CO,S	0	0	1	2
						kKu1_OH6	2012	S	0	0	0	1
		Side Arm		240.25	**kKu1b**	kKu1b		•	--	--	--	--
	Moose Cr.	***Mainstem***		255.99	kMO1	kMO1	2011	CO	0	0	1	0
						kMO1_OH1	2010	CO	0	0	5	0
		Tribs		265.77	kMOT1	kMOT1	2010	CO	0	0	3	0
							2011	CO	0	0	1	0
	George R.	***Mainstem***		290.66	**kGE2**	kGE2		•	--	--	--	--
		E. F. George R.	**Mainstem**	283.14	**kEF2**	kEF2		•	--	--	--	--
			Tribs	269.68	kEFT1	kEFT1_OH1	2010	CO	0	0	1	0
		N. F. George R.	**Mainstem**	297.80	**kNF1**	kNF1		•	--	--	--	--
			Tribs	297.71	**kNFT99**	kNFT99		•	--	--	--	--
Kuskokwim	**Tributaries**			239.58	kKUT3	kKUT3	2010	CO	0	0	1	0
				239.66	kKUT4	kKUT4	2010	CO	0	0	1	0
				245.14	kKUT6	kKUT6_OH1	2010	CO	0	0	1	0
				242.68	kKUT8	kKUT8	2010	CO	0	0	51	0
							2011	CO	0	0	12	0
						kKUT8_OH1	2010	CO	0	0	2	0
						kKUT8_OH2	2010	CO	0	0	5	0
				242.42	kKUT13	kKUT13_OH1	2010	CO	0	0	6	0
				244.37	kKUT14	kKUT14	2011	CO	0	0	2	0

1) Crossing is the code for the original surveyor's crossing location. Crossings shown in red are from ADF&G Anadromous Waters Catalog. Green shaded area indicates summer construction
2) Refer to Map Book for site locations.
3) Crossings previously documented as anadromous by the ADF&G AWC were only sampled if specific proposed infrastructure warranted further refinement of fish species present at Kuskokwim River barge landings and upper Happy River Crossing (sHA3), or to verify anadromous fish species present (e.g., various kTLT sites).
4) Salmon numbers represent counts of all fish captured during surveys (2010-2013)

Source: OtterTail (2014b)

4.2.3 Transportation Facilities

Along the proposed mine access road from Jungjuk Port to the mine site, salmon are present in Crooked, Getmuna and Jungjuk Creeks (Ottertail, 2014a) (**Figure 3.0-1**) defining these creeks as EFH. Adults of all five species of salmon enter Crooked Creek; however, most spawn downstream from the proposed access road crossing. Coho salmon are the most numerous spawners upstream from the road crossing, with Donlin Creek, approximately 4 mi (6.4 km) upstream from the road crossing, accounting for 25% of the coho observed during aerial surveys and 20% of the fall redd counts. Chinook, coho, and chum salmon spawn in Getmuna Creek, with highest densities of redds recorded downstream from the mine access road (**Figure 4.2-1**). Ottertail (2014a) estimated that over 60% of the Chinook in the Crooked Creek drainage spawn in Getmuna Creek, along with almost 50% of the chum salmon entering the drainage.

Coho salmon is the only species that has been observed during aerial surveys along Jungjuk Creek (Ottertail, 2014a). Annual coho salmon counts ranged from two fish in 2008 to eight fish in 2011. The uppermost extent of the salmon distribution is a “best-guess” estimate based on aerial observations by OtterTail (2014a). A large beaver dam complex appears to be limiting the upstream extent of coho salmon in Jungjuk Creek.

Sampling was conducted in the Kuskokwim River in vicinity of the Jungjuk Port site in 2011 and 2012 (Ottertail, 2014a). In 2011, eight sites were sampled (four upstream, three downstream and one adjacent to the proposed port site). In 2012, seven sites were sampled (four upstream, two downstream and one adjacent to the proposed port site) (**Figure 4.2-3**). Three gear types or methods were used: 1) seines, 2) fyke nets, and 3) electrofishing. Sockeye salmon were the most numerous juvenile salmon caught, comprising 89% of the captured juveniles (**Table 4.2-7**). Greatest numbers were caught by electrofishing.

The Kuskokwim River is a migration corridor for both returning adult salmon and outmigrating juveniles that access or emigrate from numerous tributaries that provide spawning and rearing habitat (**Figure 4.2-5**). However, the Kuskokwim River does not have substantial rearing habitat within the main channel during summer (Morris et al., 2015). A summary of the general run timing for adult salmon near the mouth of the river indicates that salmon are migrating up the river from early June into early September (**Table 4.2-8**).

With the exception of pink salmon, these runs form the backbone of a robust in-river harvest, with subsistence harvests being especially important (**Table 4.2-9**). Chinook salmon are most important to the subsistence economy, but chum, sockeye, and coho are also harvested.

Table 4.2-7: Results of Sampling in the Kuskokwim River near the Proposed Jungjuk Port Site (2011-2012)

		Upstream of Port								Port		Downstream of Port					
Survey		KU25	KU24	KU23	KU11	KU12	KU9		KU10	KU8		KU20	KU14		KU13	KU15	Total Fish
Method	Species	2012	2012	2012	2011	2011	2011	2012	2011	2011	2012	2012	2011	2012	2011	2011	
Seine	Chinook salmon	--	1	--	--	--	--	--	1	2	--	--	--	--	--	--	4
	Chum salmon	--	--	--	--	--	--	--	2	--	--	--	1	--	--	--	3
	Coho salmon	--	1	--	--	--	--	--	--	1	--	--	1	--	1	--	4
	Pink salmon	--	--	--	--	--	--	--	3	--	--	--	--	--	--	--	3
	Sockeye salmon	16	22	--	4	4	--	--	9	--	--	--	1	9	3	--	68
	Total # Salmon Captured	16	24	--	4	4	0	--	15	3	--	--	3	9	4	0	82
	# Seine Tows	3	4	--	3	3	3	--	3	3	--	--	7	6	3	3	41
	# Fish/Tow	**5.3**	**6.0**	--	**1.4**	**1.3**	**0.0**	**--**	**5.0**	**1.0**	**--**	**--**	**0.4**	**1.5**	**1.3**	**0.0**	**2.0**
	# Species (All Samples)	1	3	--	1	1	6	--	4	2	--	--	3	1	2	6	44
Fyke	Coho salmon	--	-	--	-	--	--	--	-	-	1	2	--	-	-	-	3
	Sockeye salmon	--	-	--	-	--	--	--	1	-	-	-	--	-	1	-	2
	Total # Salmon Captured	--	0	0	0	--	--	--	1	0	1	2	--	0	1	0	5
	# Fyke Net Sets	--	1	1	1	--	--	--	1	3	1	1	--	1	1	1	12
	# Fish/24hr Set	**--**	**0.0**	**0.0**	**0.0**	**--**	**--**	**--**	**1.0**	**0.0**	**1.0**	**2.0**	**--**	**0.0**	**1.0**	**0.0**	**0.4**
	# Species (All Samples)	--	0	0	0	--	--	--	1	0	1	1	--	0	1	0	2
Electrofishing	Coho salmon	-	-	--	--	--	-	-	--	2	4	12	--	--	--	--	18
	Pink salmon	-	-	--	--	--	-	-	--	1	-	-	--	--	--	--	1
	Sockeye salmon	70	14	35	--	--	3	41	--	1	53	7	--	--	--	--	224
	Total # Salmon Captured	70	14	35	--	--	3	41	--	4	57	19	--	--	--	--	243
	# Electrofishing Passes	1	1	1	--	--	1	1	--	1	1	1	--	--	--	--	8
	# Fish/pass	**70.0**	**14.0**	**35.0**	**--**	**--**	**3.0**	**41.0**	**--**	**4.0**	**57.0**	**19.0**	**--**	**--**	**--**	**--**	**30.4**
	# Species (All Samples)	1	1	1	--	--	1	1	--	3	2	2	--	--	--	--	3

Source: OtterTail (2014a)

Table 4.2-8: Summary of Kuskokwim River Salmon Run Timing based on Test Fishery at Bethel, AK 1984-2003

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Chinook										
Sockeye										
Coho										
Chum										
Pink										

Dark shading indicates peak entry, light shading indicates fish present

Source: Bue (2005)

Morris et al. (2015) sampled for rearing salmon in the mainstem of Kuskokwim River from mid-May into early September. From mid-May into late-June, outmigrating chum salmon smolt were the most abundant Pacific salmon species in the catch, with over 21,000 caught during the outmigration sampling. Coho salmon were second in abundance, with 428 caught, followed by sockeye (196), pink (81), and Chinook (45). In contrast, sampling from July into September found few juvenile salmon residing within the mainstem during summer. Sockeye salmon were the most abundant salmon species in the summer catch, with 28 caught from 350 seine hauls in mainstem habitats. Coho salmon were second in abundance with 5 caught, followed by one (1) Chinook, with no chum or pink juvenile salmon captured. The results were interpreted to indicate that there was little use of mainstem habitats by juvenile salmon outside of the smolt outmigration during spring. Rearing Chinook and coho salmon were abundant in the Holokuk and Aniak rivers, two clear water tributaries sampling in August. These results were consistent with sampling at Birch Tree Crossing reported by OtterTail (2014d), where sampling by seine, fyke net, and electrofishing in July 2009 caught only 9 juvenile sockeye salmon. The lack of juvenile salmon within the mainstem was likely related to high turbidity and resulting low productivity in mainstem habitats compared to more productive clear water habitats within the many tributaries of the Kuskokwim drainage. Burril et al. (2009) determined that juvenile chum and other salmon species from the Kwethluk River (a tributary of the lower Kuskokwim River) migrate downstream from early May to mid-June. They found that seaward migrations for all Pacific salmon species were generally greatest when water levels were rising and during hours of low light. Based on 2003 and 2004 studies in Kuskokwim Bay, peak abundance of downstream migrating pink, coho, and sockeye salmon was greatest in late May, while chum and Chinook salmon had greatest peak abundance in mid- to late June (Hillgruber and Zimmerman, 2009). Similar findings regarding the timing of outmigrating salmon in the Yukon Delta have been observed in other studies (Martin et al., 1986).

Table 4.2-9: Estimated Salmon Utilization in the Kuskokwim River Management Area, 2007-2013

Species	Year	Commercial Harvest1[a]	Subsistence Harvest[b]	Test Fish Harvest	Sport Fish Harvest	Total Utilization	
Chinook	2007	179	100,297	305	1,478	98,117	
	2008	8,865	92,977	420	708	108,096	
	2009	6,664	83,838	470	917	86,282	
	2010	2,731	70,576	292	c	69,079	(w/o sport)
	2011	49	65,850	337	c	59,048	(w/o sport)
	2012		25,353				
	2013		50,708				
Chum	2007	10,763	76,281	3,237	391	87,994	
	2008	30,516	66,275	2,472	121	101,742	
	2009	76,790	46,047	2,741	285	123,451	
	2010	93,148	46,797	2,872	c	142,168	(w/o sport)
	2011	118,256	55,990	2,289	c	169,787	(w/o sport)
	2012		82,030				
	2013		55,828				
Sockeye	2007	703	49,613	488	322	48,852	
	2008	15,601	56,205	584	273	75,187	
	2009	25,673	38,795	515	162	61,291	
	2010	22,428	41,722	495	c	61,026	(w/o sport)
	2011	13,842	46,290	380	c	53,562	(w/o sport)
	2012		50,781				
	201		42,824				
Coho	2007	141,049	35,802	1,557	2,355	180,293	
	2008	142,862	46,848	2,984	3,755	196,064	
	2009	104,546	32,519	2,394	3,257	139,758	
	2010	58,031	35,746	1,020	c	91,157	(w/o sport)
	2011	74,108	34,287	1,207	c	104,211	(w/o sport)
	2012		29,971				
	2013		28,295				

Notes:

a) Districts 1 and 2 only; does not include personal use.
b) Estimated subsistence harvest expanded from villages surveyed as reported in Shelden et al. (2015)
c) Data unavailable at time of publication.
   2011: An additional 699 Chinook salmon were caught during commercial periods, but were retained for personal use. These fish are included in the subsistence harvest throughout the post-season subsistence harvest survey methodology.

Source: Brazil et al. (2013)

4.3. Effects of Proposed Donlin Gold Mine

Potential effects on EFH during construction, operation, closure, and reclamation of the Donlin Gold Mine primarily involve activities that could remove, alter or degrade surface water or groundwater and aquatic habitats. Mechanisms that cause direct or indirect impacts on salmon life stages include: in-stream habitat removal and disturbance, water quality degradation, wetland and riparian buffer removal, streamflow changes, stream temperature changes, and bank/streambed erosion and sedimentation (Donlin Gold PDEIS, 2014). Appendix G of the NMFS EFH EIS, subsequently updated in 2011, identifies potential impacts associated with mining, road building and pipeline installation, along with recommended conservation measures (NMFS, 2005; 2011). A summary of potential Project impacts to Pacific salmon is provided in **Table 4.3-1**.

For this analysis, three degrees of potential impact are defined: low, moderate and severe.

- Low Degree of Impact: the effect may disturb or displace EFH species, but mortalities are unlikely and fish behavior will likely return to normal after the activity ceases.
- Moderate Degree of Impact: the effect may cause mortality to a limited number of EFH species, or remove habitat in areas with low densities of EFH species.
- Severe Degree of Impact: the effect may lead to mortality or loss of habitat in spawning areas or high density rearing habitats.

The terms “no impact” or “negligible impacts are used where impacts are not expected, or are expected to be minimal,

4.3.1. Mine Site Facilities

NMFS (2005, 2011) identifies potential impacts to EFH from mining to include: (1) adverse modification of hydrologic conditions so as to cause erosion of desirable habitats; (2) removal of substrates that serve as habitat for fish and invertebrates; (3) conversion of habitats; (4) release of harmful or toxic materials; and (5) creation of harmful turbidity levels.

Direct Habitat Loss

Construction and operation of mine site facilities within the American Creek watershed would result in a loss of 4.1 mi (6.6 km) of perennial aquatic habitat, of which approximately 0.5 mi (0.8 km) is documented as anadromous water for coho salmon rearing (Johnson and Coleman, 2014b). Juvenile coho salmon were caught in the lower reaches of American Creek (**Table 4.2-3**, **Figure 4.2-3**). In American Creek, there would be a direct loss of stream channel habitat that may support up to 196 (SE=94) juvenile coho salmon due to construction of the mine pit and WRF (ARCADIS, 2013). This estimate is considered to be high because the calculation extrapolated a sample density measured at the downstream end of the impacted reach to the entire lost channel, even though juvenile coho were not found through much of the upstream area (**Table 4.2-5**). The densities of juvenile coho salmon recorded from American Creek are considered to be low within the Project Area because mean densities in Crooked Creek and other nearby tributaries (Donlin, Dome and Getmuna creeks) ranged from 2 to 18 times greater (**Table 4.2-5**).

Table 4.3-1: Potential Impacts to Salmon-Bearing Streams in the Mine Facilities Area of the Proposed Donlin Gold Project

Table 4.3-1			
Source of Impact	**Impact Duration**	**Type of Impact**	**Degree of Severity**
Construction of open pit, WRF, contact water dams, and ancillary facilities	Permanent	Loss of 4.1 mi (6.6 km) of aquatic habitat in American Creek, including about 0.5 mi (0.8 km) of coho rearing habitat	Moderate adverse impacts because of low coho densities
Construction of TSF, seepage recovery system, and ancillary facilities	Permanent	Loss of 1.5 mi (2.4 km) of aquatic habitat in Anaconda Creek, including potential to affect 865 ft (264 m) of coho rearing habitat	Moderate adverse impacts because of low coho densities
Water flow changes/losses from American and Anaconda Creeks, and pit dewatering	Construction & Operation	Decreased stream flow for Crooked Creek between American Creek and Getmuna Creek, see **Table 4.3-2** for timing and amount of reduction	Low adverse impacts to rearing Chinook and coho salmon during summer because the change in flow results in less than 5% reduction in habitat in the areas with highest abundance of rearing salmon Low adverse impacts to rearing Chinook and coho salmon during winter because the change in flow generally results in less than 10% reduction of habitat in the areas with highest abundance of rearing salmon Low adverse impacts to most spawning salmon because most spawning is confined to areas where flow reduction is moderated by inflows from Getmuna and Bell Creeks Low to moderate adverse impacts to spawning coho between American Creek and Crevice Creek because decreased stream flow will decrease available spawning area
	Construction & Operation	Loss of connectivity to off-channel habitats; loss of off-channel habitat area; see **Table 4.3-3** for amounts and locations of loss	Moderate adverse impacts to rearing Chinook and coho salmon because there is an overall loss of 26% of connected habitat relative to baseflow conditions

Table 4.3-1			
Source of Impact	**Impact Duration**	**Type of Impact**	**Degree of Severity**
	Construction & Operation	Habitat modification of substrates or channel configuration that serve as habitat for fish and invertebrates	Low potential for adverse impacts in areas away from the mine facilities to moderate in stream reaches adjacent to mine activities
Water temperature changes from alteration to groundwater flow	Construction & Operation	Minor increases in water temperature caused by reduced groundwater inflow	Low potential for adverse impact because temperature changes are within natural range for salmonids
Fuel transport, refueling. Handling of POL and other chemicals.	Construction, Operation, Closure, and Reclamation	Potential release of harmful or toxic materials	Low; adverse effects only if there is an accidental spill
Stormwater Runoff/Waste Water Management	Construction, Operation, Closure, and Reclamation	Potential release of harmful or toxic materials	Stormwater (through BMPs) and wastewater will be managed to meet water quality standards that are protective of EFH. There should be no adverse impacts from these sources
Blasting for rock removal.	Construction and Operation	Pressures and vibrations have the potential to cause mortality to salmonids	Low to moderate depending on stream and location
Instream construction work	Construction and Operation	Creation of harmful turbidity levels	Low to moderate depending on stream and location

POL = petroleum, oils, and lubricants

BMP = Best Management Practice

The TSF would be in the Anaconda Creek drainage. Construction and operation of the TSF would result in a loss of 1.5 mi (2.4 km) of aquatic habitat for resident fish and aquatic invertebrates. Approximately 865 ft (264 m) of stream channel upstream from the mouth of Anaconda Creek is catalogued as Anadromous Water for coho salmon rearing by ADF&G (Johnson and Coleman, 2014b). The upper end of the anadromous reach is approximately 1.5 mi (2.4 km) downstream from the downstream boundary of the proposed TSF.

Streamflow Changes and Aquatic Habitat

During mining operations, surface runoff from rainfall, snowmelt, and groundwater seepage in many parts of the Project area will be diverted and captured (stored). Once captured and stored, this water will be entrained in the tailings, lost in the milling processes, consumed in the power plant operations, lost to the atmosphere through evaporation, or treated and released to Crooked Creek near the confluence with Queen Gulch. (BGC, 2013a; BGC, 2014) The water treatment and management reduces the need for water retention on site. Regardless of its final use or consumption, diversion and storage of waters will reduce the runoff that would normally reach surface waters (OtterTail 2015).

Streamflow impacts on the Crooked Creek mainstem primarily would extend between the confluence of Queen Gulch and Anaconda Creek (**Table 4.3-2**). In the lower reaches of Crooked Creek (below Getmuna

Creek) and in the Kuskokwim River, the effect of flow reductions would be low due to inflows from the undisturbed Getmuna and Bell Creek drainages. Impacts on surface flows in the affected tributaries and middle reaches of Crooked Creek would persist beyond the life of the project.

Predicted streamflow decreases also would reduce the amount of aquatic habitat available in the mainstem of Crooked Creek. As flows reduce, the water elevation (stage) would drop, thereby decreasing the wetted stream channel surface area. This would decrease aquatic habitat available for fish and benthic invertebrate production. Potential changes in water depth in Crooked Creek during proposed Project operations would vary seasonally with the particular phase of mining operations and with the distance downstream from the mine site. Using stage-discharge rating curves and stream channel contour mapping, impacts of flow decreases on aquatic habitat surface area in the mainstem of Crooked Creek were estimated for summer and winter season low flow conditions (OtterTail, 2015).

Estimates of Crooked Creek habitat loss were predicted based on Year 20, monthly 10-year low flow projections. On a percentage basis, the greatest reduction in winter streamflow in Crooked Creek during Year 20 of operation was predicted to occur between American Creek and Omega Gulch in March under a 10-year low flow scenario. Year 20 of operation is when the lowest water table elevation is predicted as a result of mine dewatering, approximately -1,100 ft amsl (-335 m amsl). During such time and conditions, streamflow is predicted to be reduced by about 30 to 34% during February and March (OtterTail, 2015).

Summer Streamflow Changes

In Crooked Creek, the lowest summer flows typically occur in June. A 10-year low flow scenario in June during Year 20 of proposed Project operations is predicted to result in flow reductions between American Creek and Crevice Creek (**Table 4.3-2**). The flow reductions were estimated to reduce overall habitat by 4% to 7%, with the greatest reductions being in riffles (3% to 7% reduction). Riffles provide habitat for macroinvertebrates that are an important food source for rearing salmon. Reductions in run and pool habitat, which are important for rearing Chinook and coho, are estimated to be in the range of 2% to 4%. Reductions in habitat of this magnitude are within the natural range of variation, and impacts to rearing juvenile salmon are expected to be low.

Impacts on Crooked Creek flows downstream of Getmuna Creek during proposed Project operation would be negligible, due to the large inflow contributions from Getmuna Creek. BGC (2014) estimated that Crooked Creek flows at Getmuna Creek would add 42 cfs (1.9 m^3/sec) to the 38.5 cfs (1.1 m^3/sec) estimated for Crooked Creek at Crevice Creek, while an additional 24.4 cfs (0.7 m^3/sec) would be added at Bell Creek, under the estimates for low flow scenarios.

Table 4.3-2: Estimated Reductions in Aquatic Habitat Surface Area for Summer and Winter, Average and Low Flow Conditions during Year 20 of Mine Operations

Crooked Creek Stream Section	Parameter	Habitat Type	# of Units	Summer: Undisturbed Summer Mapped Discharge Average	Summer: Undisturbed Summer (June) Low flow (10th Percentile)	Summer: Disturbed Summer (June) Low flow (10th Percentile) 20-year operations	Summer: Percent Reduction of Habitat from Low flow	Winter: Undisturbed Winter (Jan) Average	Winter: Undisturbed Winter (March) Low flow (10th Percentile)	Winter: Disturbed Winter (March) Low flow (10th Percentile) 20-year operations	Winter: Percent (%) Reduction of Habitat from Low flow
Crooked Creek Below American Creek (CCBAM)	Stage (m)			1.49	1.09	1.01		1.00	0.69	0.56	
	Habitat Area (ac)	Riffles	29	2.70	1.61	1.52	6%	1.51	1.14	1.00	12%
		Runs	55	7.40	6.29	6.14	2%	6.13	5.58	5.35	4%
		Pools	32	3.32	2.94	2.89	2%	2.89	2.71	2.64	3%
		Total	**116**	**13.42**	**10.84**	**10.54**	**3%**	**10.53**	**9.43**	**8.99**	**5%**
Crooked Creek Below Omega Gulch (CCBO)	Stage (m)			1.45	1.01	0.95		0.91	0.58	0.48	
	Habitat Area (ha)	Riffles	22	2.01	1.15	1.12	3%	1.09	0.90	0.84	6%
		Runs	54	13.35	10.97	10.78	2%	10.67	9.70	9.42	3%
		Pools	19	2.82	2.50	2.47	1%	2.45	2.30	2.25	2%
		Total	**95**	**18.18**	**14.62**	**14.37**	**2%**	**14.22**	**12.90**	**12.51**	**3%**
Crooked Creek Below Anaconda Creek (CCBA)	Stage (m)			1.46	0.92	0.87		0.87	0.53	0.42	
	Habitat Area (ha)	Riffles	14	3.25	1.04	0.98	7%	1.00	0.67	0.53	22%
		Runs	24	10.64	8.41	8.16	3%	8.25	7.19	6.64	8%
		Pools	3	0.58	0.49	0.48	2%	0.48	0.44	0.42	4%
		Total	**41**	**14.47**	**9.94**	**9.62**	**3%**	**9.73**	**8.31**	**7.59**	**9%**
Crooked Creek Below Crevice Creek (CCAC)	Stage (m)			1.52	0.99	0.90		0.89	0.53	0.43	
	Habitat Area (ha)	Riffles	64	18.73	10.45	9.77	6%	9.69	6.70	6.01	10%
		Runs	81	53.83	43.19	41.66	4%	41.47	35.67	33.82	5%
		Pools	13	4.22	3.50	3.39	3%	3.38	2.98	2.86	4%
		Total	**158**	**76.78**	**57.14**	**54.83**	**4%**	**54.55**	**45.34**	**42.69**	**6%**

Notes:
Some totals may not sum due to rounding.
m = stage in meters
ha = habitat area
Source: OtterTail (2015)

Winter Streamflow Changes

For Crooked Creek, the lowest winter flows typically occur in March. A 10-year low flow scenario in March during Year 20 of proposed Project operation is also predicted to result in flow reductions in Crooked Creek during winter (**Table 4.3-2**). The predicted loss of flow during winter is estimated to cause a 3% to 9% overall loss of habitat within the defined reaches of Crooked Creek, with the greatest loss again being in riffle habitat (6% to 22%). Deeper habitats, such as pools where wintering juvenile salmon would be expected, are estimated to decease by 2 to 4%. Reductions in habitat of this magnitude are within the natural range of variation, and impacts to rearing juvenile salmon are expected to be low.

Streamflow Changes and Off-Channel Aquatic Habitat

During construction, operation and maintenance, and closure, a reduction in Crooked Creek flow could cause geomorphic changes to the stream channel. These changes could include a slight narrowing of the bankfull width of the channel and encroachment (expanded growth) of riparian vegetation. Reduced flows also could affect the frequency with which off-channel habitat, such as isolated backwaters and oxbows, maintains connection with the main channel. Off-channel habitats along Crooked Creek are used by rearing coho salmon, which were the only EFH species found in these habitats during 2013 (OtterTail, 2014a). A reduction in off-channel or in-channel winter habitat may adversely affect the survival of overwintering juvenile coho salmon if flows are reduced to the point where the water column becomes too shallow and freezes completely.

The number of off-channel units and corresponding areas connected to the main channel relative to estimates of total off-channel habitat surface area were calculated for baseflow conditions, at baseflow minus 16% (see Notes in **Table 4.3-3**), and at flows representing 25-, 50-, 75-, and 100% of bankfull (OtterTail, 2012b) (**Table 4.3-3**). Crooked Creek <u>from Donlin Creek downstream to American Creek</u> has a high percentage of off-channel habitat surface area connected to the main channel at baseflow (89%). A 16% flow reduction from baseflow conditions, based on predicted flow depletion estimates in this reach in Year 20 of operations, is predicted to result in a 5% change in off-channel habitat connectivity (from 89% to 84%) and a 20% reduction in connected off-channel habitat surface area (reduced from 0.66 acre to 0.53 acre [0.27 hectare to 0.21 hectare) (OtterTail, 2012b). The greatest loss of off-channel habitat is predicted to be from <u>Anaconda Creek to Crevice Creek</u> where a 53% reduction in connected off-channel habitat surface area is predicted (reduced from 1.75 acres to 0.82 acre) (0.71 hectare to 0.33 hectare) (OtterTail, 2012b).

Overall, along the Crooked Creek corridor between Donlin Creek and the Kuskokwim River, the range of predicted reduction in connectivity and reduced surface area of off-channel habitat during mine construction, operation, and closure is expected to have a moderate adverse effect on rearing coho salmon that will persist throughout the Project duration. The greatest impact would be to rearing coho salmon between Donlin Creek and Getmuna Creek during winter.

Streamflow Changes and Salmon Spawning Habitat

Habitat losses from flow reductions can result in adverse impacts to both the availability of suitable spawning areas and the viability of eggs incubating in salmon redds during winter, particularly under low flow. However, based on the distribution of salmon redds documented in the mainstem Crooked Creek in 2009 by OtterTail Environmental, Inc. (2012e), there would be no adverse impact to salmon spawning habitat in the lower reaches of the creek despite predicted flow reductions in the middle reaches of the mainstem near the mine. This is primarily due to the large proportion of inflows contributed to the mainstem channel in the lower drainage from Getmuna and Bell Creeks. The average June baseflow in Year 10 for Crooked Creek at Crevice Creek is estimated to average 83 cfs (2.4 m^3/sec), at Getmuna Creek the estimated average almost doubles to 163 cfs (4.6 m^3/sec), and further increases to 226 cfs (6.4 m^3/sec) at Bell Creek (BGC, 2014). Salmon redds observed in 2009 were distributed far more abundantly in the lower reaches of Crooked Creek where proportionally higher baseflows typically occur as compared to reaches farther upstream near the mine site (OtterTail, 2012b).

Table 4.3-3: Off-Channel Habitat Connectivity and Estimated Surface Area for Various Flow Conditions for Mainstream Crooked Creek (2009)

Flow Conditions	Parameter	Reach Description	HAB5 Flat to American	HAB4 American to Anaconda	HAB3 Anaconda to Crevice	HAB2 Crevice to Getmuna[2]	HAB1 Getmuna to Mouth[3]	Total
Baseflow Minus 16%[1]	Total Area	acres	0.63	1.90	1.47	10.4	3.20	17.60
	Units Connected	#	7	11	1	10	2	31
	Area Connected	acres	0.53	1.83	0.82	5.75	2.34	11.27
	% Connected [4]	%	84	96	56	55	73	64
	% Baseflow Loss	% Loss	20	17	53	30	4	26
Baseflow	Total Area	acres	0.74	2.26	1.75	12.38	3.81	20.95
	Units Connected	#	10	11	3	12	3	39
	Area Connected	acres	0.66	2.20	1.75	8.22	2.45	15.29
	% Connected [4]	%	89	97	100	66	64	73
25% Bankfull1	Total Area	acres	0.98	3.36	2.36	17.37	5.63	29.70
	Units Connected	#	12	13	3	12	3	43
	Area Connected	acres	0.91	3.33	2.36	11.34	3.92	21.86
	% Connected [4]	%	93	99	100	65	70	74
50% Bankfull1	Total Area	acres	1.22	4.46	2.96	22.36	7.44	38.44
	Units Connected	#	13	14	3	14	3	47
	Area Connected	acres	1.22	4.46	2.96	15.64	5.39	29.67
	% Connected [4]	%	100	100	100	70	72	77
75% Bankfull1	Total Area	acres	1.67	6.31	4.31	30.58	10.33	53.20
	Units Connected	#	13	14	3	14	3	47
	Area Connected	acres	1.67	6.31	4.31	25.32	7.08	44.68
	% Connected [4]	%	100	100	100	83	69	84
Bankfull1	Total Area	acres	2.11	8.17	5.65	38.81	13.22	67.96
	Units Connected	#	13	14	3	21	4	55
	Area Connected	acres	2.11	8.17	5.65	38.81	13.22	67.96
	% Connected [4]	%	100	100	100	100	100	100

Notes:

1. Table represents off-channel habitats with connectivity at or below bankfull stage only. A 16% reduction represents flow deple estimates from Crooked Creek at American Creek (BGC, 2011b).
2. Lower portions of reach HAB2 may not experience 16% flow reductions due to tributary contributions.
3. Getmuna to the mouth of Crooked Creek would not likely experience a 16% reduction in baseflow due to tributary contributions.
4. % Connected = Area Connected/Total Area.

Conversion: 1 acre = 0.4 hectare

Source: OtterTail (2012b)

Impacts of flow reductions from mine construction and operation on salmon spawning redds were evaluated using a flow depletion model to predict conservative estimates of decreases in water surface elevation and known locations and depths of salmon redds as measured during 2009 spawning surveys. Based on this analysis, it was determined that 65% (11 of 17) of the redds in Crooked Creek between American Creek and Anaconda Creek and 78% (7 of 9) of redds between Anaconda Creek and Crevice Creek were located in gravels that would be outside the predicted wetted portions of the stream channel during winter low flow conditions during construction and operation. From Crevice Creek to Getmuna Creek, 2% (3 of 144) of redds observed during the 2009 survey would have been above the predicted winter low flow water line during proposed Project operation. Most redds in the reach between American Creek and Crevice Creek are likely from coho salmon because the redds were detected during fall surveys when coho salmon were present (OtterTail, 2014a). Impacts of reduced flow may range from low to moderate depending on the availability of alternative suitable spawning habitat for coho salmon.

Of the 532 salmon redds observed in 2009 during summer ground surveys along the mainstem Crooked Creek, more than 94%were downstream of Crevice Creek and over 88% were from approximately 4 mi (6.4 km) upstream from Getmuna Creek to the Kuskokwim River (OtterTail, 2012b). Aerial observations from surveys conducted from 2004 to 2010 documented an annual average of 354 adult salmon in the Crooked Creek mainstem with 314 (88%) observed between Crevice Creek and the Kuskokwim River and 295 (83%) observed from approximately 4 mi (6.4 km) upstream from Getmuna Creek to the Kuskokwim River. Along the middle reaches of the creek near the mine site, the observed adult salmon density was considerably lower where an annual average of 40 adult salmon (12%) were observed, consisting primarily of coho and chum salmon. This indicates that in recent years salmon distribution has been relatively limited in the middle reaches of Crooked Creek and that relatively fewer summer redds produced near the mine site would be subject to flow reductions predicted to occur in this area during proposed operation.

Streamflow Changes and Freezing of Spawning Substrates

From late September 2010 to early June 2011, a study was conducted to assess the depth of stream substrate freezing along the mainstem of Crooked Creek between Flat Creek and Getmuna Creek. This study was conducted under low flow conditions and focused on areas where potential salmon spawning would be expected near the tails of pools. Based on the flow conditions observed during the study, substrate freezing was not observed in water depths greater than 1.6 ft (0.5 m). This indicates that potential over-wintering habitat for juveniles and incubating salmon eggs exists in certain areas of Crooked Creek (OtterTail, 2012c).

Summer and winter flow reductions are anticipated in the middle reaches of Crooked Creek near the proposed mine site, but are not expected to be adverse impacts to salmon redds in the Crooked Creek mainstem. The majority of observed spawning habitat and adult salmon spawning distribution occurred in the lower river where predicted reductions of winter baseflows would be substantially buffered by tributary inflows (BGC, 2013a; 2014).

Streamflow Changes and Salmon Production

Estimated changes to the flow regime in the Crooked Creek mainstem during proposed mine operation and closure are not expected to result in adverse impacts on salmon production of the Kuskokwim River system because the Crooked Creek drainage comprises less than 1% of the total area of the Kuskokwim River watershed (Wang, 1999). Based on 2008 to 2012 weir counts near the mouth of Crooked Creek, the average annual salmon escapement totaled 3,600 fish. The annual averages consisted of 59 Chinook salmon (range 29 to 100); 1,907 chum salmon (range 832 to 3,755); and 1,634 coho salmon (range 591 to 4,204) (OtterTail, 2012b).

As previously described in Section 4.2.1, the distribution of adult spawning salmon in the Crooked Creek mainstem was determined from aerial surveys conducted between 2004 and 2010 where an annual average of 354 salmon was documented. Of these, 314 (88%) were observed between Crevice Creek and the Kuskokwim River; however, the majority, 295 (83%) were observed farther downstream from Eagle Creek to the Kuskokwim River. Over these years, an annual average of 40 adult salmon (12%) were documented either upstream of the proposed mine site or in the middle reaches of Crooked Creek west of the mine site.

While salmon escapement values for the entire Kuskokwim River system are not available, because all tributaries are not surveyed or enumerated, annual ADF&G Chinook salmon escapement goals for all 14 monitored tributaries combined were 25,050 to 59,730 (aggregate escapement goal range) (Conitz et al., 2012). By comparison, the average 2008 to 2012 Chinook salmon escapement at the Crooked Creek weir represents between 0.1% and 0.2% of the total escapement goal range for all 14 Kuskokwim River stocks for which escapement goals have been established.

Similarly, the average 2008 to 2012 chum salmon escapement past the Crooked Creek weir represents 0.3% to 0.8% of the total escapement goal for the four Kuskokwim River stocks for which escapement goals have been established (Conitz et al., 2012). The average 2008 to 2012 coho salmon escapement past the Crooked Creek weir represents 3.4% to 4.9% of the total escapement goal for the three Kuskokwim River stocks for which escapement goals have been defined (Conitz et al., 2012).

Predicted reductions in surface flows, instream habitat quantity and quality, and over-wintering conditions in Crooked Creek due to the proposed Project are predominately limited to the middle reaches of Crooked Creek near the proposed mine site and well upstream of Getmuna Creek. In recent years, spawning salmon densities within the middle reaches of Crooked Creek have been limited; whereas, most Chinook, coho, and chum salmon spawning has been observed downstream of Getmuna Creek and/or within Getmuna Creek and Bell Creek (OtterTail, 2012b). Thus, any percentage comparison of total salmon escapement based on Crooked Creek weir counts versus total escapement goals for the Kuskokwim River system tends to reflect the relative contribution of Crooked Creek stocks that primarily spawn in the lower reaches of Crooked Creek. Therefore, there is no anticipated adverse impact from the proposed mine operation and closure relative to total salmon abundance in the overall Kuskokwim River drainage. However, there is expected to be an adverse impact to rearing habitat available to Chinook and coho salmon, and spawning habitat for coho salmon, in the reaches adjacent to and immediately downstream from the mine site area.

Stream Temperature Changes

The potential for stream temperature changes to have adverse effects on EFH were evaluated and determined to be negligible, although they vary between mine construction and operation and mine closure. During construction and operation, stream temperatures in drainages downstream of the mine facilities are anticipated to remain relatively constant. Both surface water and groundwater from the American Creek and Snow Gulch drainages would be diverted to the mill processing circuit. While this would reduce the volume of flow ultimately reaching Crooked Creek, the amount of heat energy per unit volume of water would not be expected to appreciably change.

Discharges

Treated water from mine operations would be discharged to Crooked Creek pursuant to an individual Alaska Pollutant Discharge Elimination System (APDES) permit. The water would be treated to meet drinking and aquatic life water quality standards and therefore would not be expected to have an adverse effect on EFH.

Proposed mining activities during construction, operation, and reclamation have the potential to release sediment into local drainages and tributaries from a range of activities and sources due to:

- soil disturbance and vegetation removal
- wetland in-filling that reduces sediment retention and exposes soils to erosive forces of wind and/or water
- stream erosion from increased flows resulting from inter-basin diversions and transfers
- runoff from constructed roads, airstrips, and materials sites

However, a comprehensive array of construction and operational BMPs, featuring erosion, sediment, and stormwater control systems, will be incorporated into the proposed Project as discussed in Section 5.0. Discharges of stormwater would be authorized under the APDES Construction General Permit (during construction) and Multi-Sector General Permit (during operation), which requires implementation of Stormwater Pollution Prevention Plans (SWPPPs) and BMPs to provide a means to ensure that stormwater discharges do not exceed water quality standards. These and other mitigation measures are described in Section 5.0. BMPs are expected to be effective to minimize sediment additions; therefore, no adverse effects on EFH are expected due to sedimentation.

Blasting

Frequent blasting activity would occur as the open pit is developed. Because the east side of the open pit would be within close proximity to Crooked Creek (< 1,000 ft) (<305 m), it is possible that fish could be affected by this activity at some point during pit development. More infrequent blasting could occur during Project construction at other locations of the Project on an as-needed basis. It is anticipated that blasting agents would consist of 70% emulsion and 30% ammonium nitrate and fuel oil (ANFO), based on projected moisture conditions. Pressures and vibrations generated from blasting have the potential cause mortality to salmonids (ADF&G, 2013). Shock can also cause mortality of eggs or larvae. The sensitivity to shock varies with the developmental stage of fish (ADF&G, 1991). The estimated pressure and vibration forces generated by blast forces have not been calculated yet, pending future pit development plans. The use of blasting within or near fish-bearing waterbodies will be reviewed by the State with input from ADF&G. Regulatory compliance and collaboration with agency staff would occur as the final stages of the proposed Project design are accomplished. Following ADF&G blasting standards will likely result in no adverse effects to fish life stages from blasting for those stream reaches in close proximity to the mine area. Stream reaches with the greatest habitat use by EFH species (i.e. Getmuna Creek, Bell Creek, and lower Crooked Creek) are far enough from any blasting that adverse impacts would not be expected.

4.3.2. Natural Gas Pipeline

The natural gas pipeline would cross numerous streams within the Cook Inlet, Skwentna, Yentna, and Kuskokwim drainages. Mainstem salmon habitat streams crossed by the proposed pipeline route include: Theodore River, Lewis River, Alexander Creek, Swentna River, Eightmile Creek, Shell Creek, Happy River, Skwentna tributaries, Yentna River, South Fork Kuskokwim River, Windy Fork Kuskokwim River, Middle Fork Kuskokwim River, Big River, Tatlawiksuk River, Kuskokwim River, Moose Creek, Moose Creek tributaries, George River, East Fork George River, North Fork George River, and Kuskokwim River tributaries. Excluding the Yentna, all major drainages along the proposed pipeline route (Cook Inlet, Skwentna, and Kuskokwim) are classified as EFH under the MSFCMA.

Habitat and Hydrology Modifications

Probable short-term impacts are alteration or temporary loss of fish habitat in the immediate vicinity of work activity and temporary obstruction to fish passage during construction (**Table 4.3-4**). Temporary loss of habitat may result from diverting rivers or stream channels, removing riparian vegetation, excavating streambed materials, or altering water quality (SRK Consulting, 2013). Other potential impacts could occur as a result of stormwater runoff carrying suspended solids, and reduced flows during withdrawals for ice-road construction. Effective implementation of BMPs during pipeline construction and operation provide a means to avoid adverse effects to salmon streams. A comprehensive selection of construction and operational BMPs, including erosion, sediment, and stormwater control systems would be implemented in the proposed Project. Examples of control measures to be implemented are included in Appendix H of the Natural Gas Pipeline Plan of Development (SRK Consulting, 2013). Over 68% of pipeline construction would be completed during winter conditions to limit impacts of soil and surface water disturbance. **Table 4.2-6** indicates the eight pipeline crossings that would be constructed during summer. Of these, three crossings would be accomplished using HDD methods in the George River drainage.

Water Removal and Use

Potential impacts to EFH from construction of the natural gas pipeline could result from the withdrawal of water from local lakes and streams to construct temporary ice roads and the use and release of water during pipeline hydrotesting. These activities have the potential to affect local water levels, stream flows, and water quality; however, water withdrawals are controlled by requirements specified by ADNR water use permits that establish limits, based on input from ADF&G, on the amount of water that can be withdrawn from various sources to protect fish. The rate and volume of water withdrawal would be monitored at each source to ensure permit compliance so that over-wintering fish populations are sustained.

Discharge of hydrostatic testing water requires authorization from the Alaska Department of Environmental Conservation (ADEC, 2012) and must meet applicable water quality standards. Based on the effective implementation of these measures and proposed compliance monitoring, no adverse impacts to Pacific salmon are expected from water withdrawal during pipeline construction and hydrostatic testing.

Table 4.3-4: Potential Impacts to Salmon-Bearing Streams along the Proposed Natural Gas Pipeline

Source of Impact	Impact Duration	Type of Impact	Degree of Severity
Temporary stream diversions for pipeline trenching activities & water extraction	Construction	Modification of hydrologic conditions	Low, most construction is scheduled for winter; Tatina River, Moose Creek, 1 Moose Creek tributary and 7 crossings in the George River scheduled for summer construction (see **Table 4.2-6**)
Instream construction work	Construction	Habitat modification of substrates or channel configuration that serve as habitat for fish and invertebrates	Low, most construction is scheduled for winter; Tatina R, Moose Creek, 1 Moose Creek tributary and 7 crossings in the George River scheduled for summer construction (see **Table 4.2-6**)
Water withdrawal	Construction	Reduction in Wintering Habitat	Low, permits for water removal set criteria to avoid impacts to wintering fish
Stormwater runoff	Construction	Creation of harmful turbidity levels	Low, most construction is scheduled for winter; Tatina R, Moose Creek, 1 Moose Creek tributary and 7 crossings in the George River scheduled for summer construction (see **Table 4.2-6**)
Fuel transport, refueling. Handling of POL and other chemicals. HDD drilling. Hydrostatic testing	Construction and Reclamation	Potential release of harmful or toxic materials	Low, construction is scheduled for winter, except 3 HDD crossings in the George River are scheduled for summer

Spills and Leaks

Risks relating to spills or leaks of fuel during pipeline construction or operation would be reduced by implementing appropriate prevention, inspection, maintenance, monitoring, and response programs. Fuel would be dispensed to the contractor's fuel trucks on the ROW or at camp. There would also be a propane storage facility so that contractors can refuel their preheat equipment. Appropriate spill containment kits and procedures would be in place to address fueling and spills while fueling.

Blasting

During pipeline construction some blasting may be required in the Project Area primarily associated with material borrow sites. All blasting would be conducted in accordance with state and federal regulatory requirements. This topic is covered in greater detail in Section 4.3.1.

Horizontal Directional Drilling

HDD is proposed to be used to cross six major EFH drainages; however, the drilling technique poses some potential for impacts from loss of fluid through subsurface fractures (frac-out), unconsolidated gravel or coarse sand. Drilling mud (fluid) used in HDD poses a low risk to water bodies and wetlands.

After HDD begins, specific monitoring would be conducted to determine whether a subsurface fluid occurs. To provide a means to ensure that the pressure on the drilling fluid is set to match the formation, the pressure levels would be set as low as possible and closely monitored. The pressure should not exceed what is needed to penetrate the formation. A significant drop in the pressure, or drop in mud return, could indicate a potential fluid loss and drilling would be halted immediately. Details regarding prevention, detection, and response to a potential frac-out or drilling fluid release would be addressed in the HDD Plan and Spill Prevention Control and Countermeasures (SPCC) Plan. Impacts to salmon from HDD construction are expected to be low because the activity will be conducted under BMPs, the drilling mud used is non-toxic, and any increase in turbidity caused by a low-probability fluid loss would be temporary.

4.3.3. Transportation Facilities

Proposed transportation facilities include a port at Jungjuk Creek on the Kuskokwim River, an access road that connects the mine to the Port, and an airstrip at the mine site. Fuel and cargo would be transported along the Kuskokwim River by barge to Jungjuk Port. Potential impacts from the proposed transportation facilities are summarized in **Table 4.3-5**.

Mine Access Road

The access road from Jungjuk Port to the mine site, will cross about 50 streams or drainages, six of those are EFH that are planned to be crossed by bridge (**Table 4.3-6**). Culverts for smaller, non-fish-bearing crossings would vary in diameter from 24- to 72 inches. Starting from the proposed Jungjuk Port site, the streams include several unnamed tributaries to the Kuskokwim River and Jungjuk Creek, Jungjuk Creek, south and north forks of Getmuna Creek, an unnamed tributary of the South Fork of Getmuna Creek, an unnamed tributary of the North Fork of Getmuna Creek, and Crooked Creek.

Instream Work. Along the mine access road, impacts associated with construction and operation could temporarily degrade water quality and therefore affect salmon populations. One two-lane steel girder bridge and five steel-arch bridge structures would be used, which should minimize alteration of flow and habitat at these crossing sites. Fish passage design standards developed by ADF&G will be used to accommodate anticipated levels of flow, maintain sufficient channel width, and minimize slope changes. The remaining streams, which are non-fish-bearing, would be crossed by installed culverts.

Increased Turbidity. Stormwater would be managed by implementing BMPs. With adherence to Project BMPs during construction and operation, impacts to salmon from increased turbidity resulting from stormwater runoff should be low, and there are likely to be no long-term adverse impacts to salmon habitat due to the mine access road.

Table 4.3-5: Potential Impacts to Salmon-Bearing Streams from Proposed Project Transportation Facilities

Source of Impact	Impact Duration	Type of Impact	Degree of Severity
Mine Access Road	Construction	Instream work on bridges/culverts. Habitat modification of substrates or channel configuration that serve as habitat for fish and invertebrates	Low because bridges will be used to cross EFH streams
	Construction	Potential for elevated turbidity levels during construction	Low with implementation of effective BMPs; potential for moderate impacts in the event of rare accidents in EFH streams when salmon are present
	Construction	Construction and operation of floodplain material site at Getmuna Creek	Low with implementation of effective BMPs. The material site has no connection to Getmuna Creek, so there should be no direct impacts.
	Permanent	Fuel transport, refueling. Handling of POL and other chemicals. Potential release of harmful or toxic materials	Low with implementation of effective BMPs and SPCC plans. Potential for moderate impacts in the event of rare uncontrolled spills in EFH streams when salmon are present
Jungjuk Port	Construction and Operation	Increased turbidity from dredging during construction, propeller wash during operation	Negligible during most of the year when salmon are absent, low potential for impacts during juvenile outmigration
	Construction	Pile driving to install sheet piles	Low during most of the year when salmon are absent, moderate during juvenile outmigration
	Permanent	Fuel transport, refueling. Handling of POL and other chemicals. Potential release of harmful or toxic materials	Low with implementation of effective BMPs and SPCC plans. Potential for moderate impacts in the event of rare uncontrolled spills when salmon are present
Increased barge traffic	Construction, Operation, and Closure	Increased boat wake effects, which could increase current shoreline erosion rates, habitat and water quality degradation	Low, mostly confined to smolt outmigration at locations along cut-banks where the channel narrows.
	Construction, Operation, and Closure	Fish displacement and stranding	Low, mostly confined to smolt outmigration at locations with shallow gradient shoals exposed to wave run-up.
	Construction, Operation, and Closure	Possible increase in fish injury or mortality for propeller strikes during barge maneuvering	Low, mostly confined to mid-channel region near the thalweg during smolt outmigration from mid-May to late June
	Construction, Operation, and Closure	Bed scour and associated increased turbidity	Low, temporary displacement of migrating salmon
	Permanent	Fuel transport, refueling. Handling of POL and other chemicals. Potential release of harmful or toxic materials	Low with implementation of effective BMPs and SPCC plans. Potential for moderate impacts in the event of rare uncontrolled spills when salmon are present
	Construction, Operation and Closure	Introduction of Invasive Species	Low with compliance to recommended conservation procedures

Table 4.3-6: Proposed Bridge Crossings of EFH Streams along the Proposed Mine Access Road

Stream Name	Road MP/KM From Mine	Span feet-inches (m)	Type of Bridge
Crooked Creek	0.2 / 0.3	84-7 (25.8)	steel girder
North Fork Getmuna Creek	16.1 / 26.0	44-0 (13.4)	steel arch
South Fork Getmuna Creek	17.2 / 27.7	44-0 (13.4)	steel arch
Getmuna Tributary	17.5 / 28.2	30-5 (9.3)	steel arch
Jungjuk Creek, Upper Crossing	24.1 / 38.7	29-0 (9.0)	steel arch
Jungjuk Creek, Lower Crossing	24.8 / 39.9	40-2 (12.2)	steel arch

Floodplain Material Sites. Material site MS-10, at the confluence of the north and south forks of Getmuna Creek, will consist of a series of eight cells covering approximately 205 acres (83 hectares) created by excavating material for the proposed mine access road from the Jungjuk Port Site to the mine area. The cell complex is close to both the south and north forks of Getmuna Creek. Fish abundance and populations are documented for the south fork of Getmuna Creek and data indicate that a number of diverse species, including coho salmon, reside in and use the reaches above and below the proposed material site for spawning and rearing. Initial evaluation of topographic and satellite imagery suggested that remnant highwater channels might exist between the proposed material site and the south fork of Getmuna Creek. However, subsequent aerial reconnaissance conducted during July 2012 revealed that these are relict channels overgrown with vegetation with no surface connection to south fork of Getmuna Creek. A late winter aerial reconnaissance was conducted in March 2012 and no observable ice overflow or *aufeis* fields were noted. Because there is no active connection to Getmuna Creek and work at the material site will be isolated from contact with the stream, there is likely to be no adverse effects to EFH from operation of the material site. At the end of its use as a material site, the remaining pit will likely fill with groundwater.

Chemical Transport and Spills. There is potential for accidental release of chemicals used in various activities associated with mining in general. Overland fuel transport would be conducted under a SPCC plan to prevent impacts to surface water quality. Operations at the Port would also require that a Facility Response Plan be developed and implemented. An Oil Discharge Prevention and Contingency Plan (ODPCP) would be developed and implemented for fuel handling and storage operations at the mine and Port, and for transportation on the Kuskokwim River. Potential for impacts to surface water quality from a release from storage tanks at the Port would be minimized through installation of secondary containment around fuel storage as required by state and federal regulations.

Jungjuk Port

Propeller Wash Erosion. Construction at the Jungjuk Port site would occur over an area of about 26 acres (10.5 hectares), but only 4.4 acres (1.8 hectares) are below the ordinary high water mark. Impacts from construction would involve loss of aquatic habitat along the shoreline where a sheet-pile wall would be installed.

During operation, tugs would maneuver barges with propeller wash disturbing riverbed substrates and local fish populations. Densities of juvenile salmon are low during most of the summer, so adverse impacts from these activities would be confined to the 5- to 6-week period of outmigration in mid-May to late June. Such impacts would occur over the duration of the Project, affecting salmon populations in the Kuskokwim River system upstream from the Port facility. Anticipated adverse impacts to EFH species are expected to be low during most of the year because few salmon use habitats outside of the outmigration and adult return migration periods. Adult salmon will likely avoid the area of activity during their return migration.

Pile Driving Impacts. Pile driving would be used to install the sheet piles to construct the bulkhead earth-retaining system needed to protect the dock against ice loading. Ruggerone et al. (2008) investigated the effects of pile-driving exposure on caged yearling coho salmon. Fish were placed in cages near (6 to 22 ft) (1.8 to 6.7 m) and far from (50 ft) (15.2 m) 14 hollow steel piles (1.67 ft diameter) (0.51 m diameter), and exposed to sound from 1,627 strikes over a 4.3-hour period. Sound levels were measured in both the near and far cages. In the near cage, peak sound pressure levels (SPL) reached 208 decibels (dB) relative to 1 microPascal (re 1 μPa) and sound exposure levels (SEL) reached 179 dB re 1 μPa2-s, leading to a cumulative SEL of approximately 207 dB re 1 μPa2-s during the 4.3-hour period. (SEL is the integration over time of the square of the acoustic pressure. It is an indication of the total acoustic energy received by an organism.) Sounds did not exceed ambient in control cages that were kept far away from the region of pile driving. Caged fish were sampled at 10 and 19 days post exposure. The investigators found no mortality in any animals, and examination of the external and internal anatomy (gross observations and not histopathology) showed no differences between exposed and control animals.

Hart Crowser et al. (2010) investigated effects of pile driving on juvenile coho salmon during construction of the Port of Anchorage Marine Terminal. The study exposed juvenile coho salmon to sound pressures generated by the impact and vibratory pile driving of sheet piles during the normal course of construction of the Port of Anchorage Marine Terminal Redevelopment Project. Despite attempts to expose fish to maximum potential noise, the study of sheet pile driving measured only relatively low levels of sound energy compared with exposures to pipe pile driving reported in the literature to cause adverse effects on fish. No immediate or delayed mortality and no evidence of barotraumatic injury associated with sheet pile driving were found.

Despite a fairly rigorous examination of existing studies and evaluation of sound sources associated with pile driving, Popper and Hastings (2009) concluded that little is known about the effects of such sounds on fish. It seems lethal effects caused by pile driving are confined to fish that are in the immediate vicinity of the activity and that impacts would be minimal if they move away from the activity. The proposed location of the Port would be in the migration route of adult salmon returning from the sea and heading for spawning areas. If a school of fish is in the immediate pile-driving area as pile driving commences, direct mortality is possible. However, Mueller-Blenkle et al. (2010) found that Atlantic cod detect noise generated from pile driving at great distances and demonstrate an avoidance response. If salmon demonstrate a similar response, schools entering the Port area while pile driving is in progress are likely to divert their route. Outmigrating juvenile salmon will be passing the Port site from mid-May to late July, while returning adult salmon will pass the site between early July and late September.

In 2008, the Fisheries Hydroacoustic Working Group, which is composed of several state and federal agencies, including NMFS, the Federal Highways Administration, and State highway agencies for

California, Oregon, and Washington, signed a memorandum agreeing to interim criteria for use during all pile driving projects. These criteria have been identified as a peak sound pressure level of 206 dB and an accumulated SEL of 187 dB for all fish weighing 2 grams or larger. For fish less than 2 grams, the criterion for accumulated SEL is 183 dB (FHWG, 2008). Impacts to fish from pile-driving activities during construction of the bulkhead earth-retaining system should be minimized if these criteria are followed. If these criteria are impractical, then in-water work windows could be used to avoid impacts during salmon migrations.

Chemical Transport and Spills. This topic is discussed in the previous section (Mine Access Road).

Kuskokwim River Barging

Waterway shipments of fuel and cargo would increase the seasonal Kuskokwim River barge traffic from baseline levels of about 68 round trips to an average of approximately 125 round trips during construction and 134 during operation (**Table 3.3-1**). Potential impacts related to the increased barge traffic on fish and aquatic resources primarily would result from vessel-induced wave energy, propeller turbulence, and possible accidental vessel groundings. At certain times and locations, increased barge traffic also may affect small-boat traffic routing and subsistence fishing activities.

Wake Effects and Stranding. Wave energy impacts to shoreline erosion are likely to be low because the primary mode of bank erosion on the Lower Kuskokwim River is thermoerosional niching associated with high water levels, normally associated with spring breakup (BGC Engineering, 2013b). Following high breakup flows, water levels recede and erosional forces tend to be low during summer, thus it was concluded that the barge-generated waves will not significantly affect bank erosion rates. An exception to this may be at cut banks composed of silts and sands where waves could influence erosion rates. Cut banks are by nature highly erosive, so a low to moderate increase in rate of erosion caused by barge wakes is likely to have little effect to salmon migrating past either as adults or outmigrating smolt.

Analyses in the Donlin PDEIS (2014) indicate that potential stranding from vessel wakes on salmon smolt migrating along shallow-gradient gravel bars would be negligible relative to upriver-bound barge traffic traveling at about 5.2 knots (6 miles per hour [mph]), because wakes generated by slow moving barges would be too small to cause adverse effects to migrating juvenile salmon. Barges returning downstream would travel at speeds approaching 10 knots (11.5 mph), which could generate wakes up to 0.74 ft (0.23 m) in height near Aniak and less than 0.6 ft (0.18 m) elsewhere in the river (BGC, 2015). Wakes of this magnitude should not produce sufficient currents to displace young-of-year salmon migrating along shorelines in the river. Morris et al. (2015) found that chum smolt used all habitats sampled during their outmigration but were captured at the highest rates in backwaters, shallow low gradient shoals and slackwaters; they also were encountered in side channel riffles at high rates. Many chum salmon smolt were in habitats that should be unaffected by barge wakes, for example in side channels and riffles where wave run-up is blocked or attenuated by an island or shoal, or in deeper offshore water and thus would not be vulnerable to potential stranding. Because of their broad distribution in variety of habitats and the predicted small size of barge wakes, the overall risk of stranding from barge wakes to chum salmon smolts is expected to be low.

Impacts from Propeller Strikes. Barge traffic navigating deeper sections of the Kuskokwim River typically would not pass close to shore, depending on the river channel width and geometry. Under such conditions, rearing or migrating salmon in shore zone areas should not be adversely affected by tug propellers, vessel wakes, drawdown and surge, propeller wash, and other associated hydraulic forces unless they are located in confined channel segments. Based on available literature, most outmigrating Chinook, coho and sockeye salmon are large enough to avoid barge propeller strikes, while a portion of the pink and chum salmon may still be small enough to be affected. For example, Killgore et al (2001) found that the magnitude of larval mortality due to shear stress caused by propellers is size-dependent with small larvae (<10 millimeters [mm]) being the most susceptible. Even juvenile chum and pink salmon greatly exceed these sizes, with chum salmon outmigrating from the Kuskokwim River in 2015 averaging 38.0 mm (range: 27 to 50 mm) and pink salmon averaging 34.5 mm (range: 30 to 42 mm) (Morris et al., 2015). Outmigrating Chinook, coho and sockeye salmon are considerably larger, with mean lengths of 83.6, 84.8, and 53.1 mm, respectively, and would be at less risk of injury.

A study of entrainment rates though propellers conducted in the Mississippi River indicated that entrainment rate was low (<1 fish/km) in deep and wide sections of the river with swift water. However, entrainment could reach high rates (>30 fish/km) in shallow sections with slow velocity (Killgore et al., 2011). This study also points out that fish may avoid entrainment in wide or deep channels, escaping vertically or horizontally, and notes that other studies have documented transient avoidance responses to boats though radiotelemetry and hydroacoustics. During the 2015 study of outmigrating salmon from the Kuskokwim River, low catch rates overall for Chinook, coho, and sockeye salmon smolt and their relatively higher catch rates compared to chum and pink salmon in mid-channel trawls suggest that many of these larger out-migrants must be using deeper water habitats for outmigration and thus many are likely not susceptible to direct impacts from tug propellers (Morris et al., 2015). Chum salmon smolt are widely distributed throughout the river during outmigration but use river margin habitats remote from the thalweg for outmigration more so than mid-channel habitats, thus making them less susceptible to direct impacts from tug propellers. The effect of each additional passing barge would be additive; however, with the large number of outmigrants coming from the numerous tributaries, which likely have some variation in the timing of outmigration, effects to any given stock are expected to be low. Given the pattern of habitat use and sizes of fish present the overall effect of propeller strikes is likely to be low during the smolt outmigration.

Impacts from Bed Scour. Barging operations are likely to scour silty sand bed material up to a depth of 3 to 4 ft (0.9 to 1.2 m) in shallow water while moving upstream, and significantly less for a moving tug in deeper water (AECOM, 2015). Bed scour from existing barge traffic, flooding, and ice-out conditions also contributes to sediment re-suspension and displacement of aquatic biota. Bed scouring would occur as long as there are barging operations, and could occur from the Jungjuk Port site to Bethel. Barging to support pipeline construction could extend to approximately 30 miles (48 km) upriver from Stony River. Barging would affect shallower sections of the Kuskokwim River along the transportation route; however, barges generally operate in water much deeper than 3 to 4 ft (0.9 to 1.2 m). Existing barge traffic is expected to already be scouring the riverbed within the navigation channel, thus displacement of aquatic biota in previously disturbed substrates would be negligible. The larger barges used in the Project would lead to some expansion of the affected area. Minimal adverse impacts are expected from bed scour on salmon as a result of barge traffic because most salmon, both juveniles and adults, primarily use the mainstem Kuskokwim during summer as a migration channel and few are selecting habitats for rearing or feeding. Some salmon may be briefly exposed to sediment plumes; however, they are likely to move away from such areas and continue their migration. Adverse effects from scouring, if any, are likely to be brief and dissipate rapidly after the barge passes.

Chemical Transport and Spills. This topic has previously been discussed.

Invasive Species. Transport of materials between West Coast ports and Bethel has the potential to introduce invasive species, which is identified by NMFS (2011) as an important issue in EFH evaluations. NMFS (2011) identifies recommended conservation measures for invasive species to avoid and minimize adverse impacts and promote the conservation, enhancement, and proper functioning of EFH. Where practicable, these recommended measures will be incorporated into agreements with shipping companies that provide transport support for the Project.

5. MITIGATION

This section describes the mitigation measures that are currently included in the Proposed Action. These measures were developed to minimize impacts on water quality and fisheries, including EFH. Several mitigation actions are proposed for Getmuna Creek. Monitoring is also described because the results of monitoring will be used to demonstrate the effectiveness of mitigation and environmental protection.

5.1. Project Monitoring

An important component of mitigation is the existence of an adequate baseline that identifies and describes EFH, which will allow Project impacts to be measured and compared to predicted impacts through an effective monitoring program. Baseline studies were initiated in 1996 and continued through 2015. Donlin Gold will develop a monitoring program for all phases of the Project so that potential impacts of each Project component to EFH can be analyzed. The program would include monitoring the effectiveness of BMPs (e.g., regular visual inspections) and environmental monitoring (water quality, sediments, bioassessment). Results of environmental monitoring would be compared to standards and baseline conditions and evaluated for trends. Monitoring would be tied to a program of remedial and contingent actions that would be implemented if actual effects to EFH are trending to exceed those predicted.

5.2. Mine Site Facilities

5.2.1. Construction and Operation

BMPs would include sediment and stormwater management and monitoring measures that extend from initial mine infrastructure development through and beyond mine closure. Sediment control measures to be included in the Multisector General Permit SWPPP would include silt fences, sediment retention basins, cross bars and ditches, runoff interception and diversion, mulching and revegetating disturbed surfaces and soil stockpiles, and other BMPs designed to reduce the intensity of surface runoff, erosion, and sediment loads in downstream drainages.

Mitigation measures to minimize effects on EFH include:

- Use construction methods that eliminate or reduce the potential for bank erosion and sedimentation into fish streams
- Limit refueling activity and storage of fuel and related liquid to at least 100 ft (30.5 m) from the bank of fish-bearing streams
- Install fish screens on all inlet suction hoses
- Comply with all ADF&G Title 16 permits as well as ADNR Temporary Water Use Permits and ADPES permits

  Comply with APDES general and individual permits that require implementation of SWPPPs and that water discharges comply with water quality standards that are protective of aquatic life.

5.2.2. Habitat Modification Mitigation Options

Getmuna Creek, which supports a significant portion of adult salmon escapement and production in the drainage, would not experience adverse impacts from mine operation because the only Project activities within the drainage are related to construction of three bridges to avoid changes to EFH (**Table 4.3-6**). MS-10, which is just upstream from the confluence of the north fork of Getmuna Creek and the south fork of Getmuna Creek, will be excavated with no connection to the creek. However, the drainage provides mitigation opportunities (Ottertail, 2012a). Two identified mitigation options are: 1) removal of an apparent migration blockage, and 2) reclaiming the Getmuna material site (MS-10) to provide fish-rearing habitat.

Getmuna Migration Blockage

The upper reaches, approximately 2 miles (3.2 km) of the south fork of Getmuna Creek may not be accessible to salmon, as indicated by a complete absence of observed salmon upstream of the natural barrier during annual aerial fish surveys. Although salmon are known to migrate upstream of their natal spawning areas – particularly coho and Chinook salmon – only Dolly Varden and slimy sculpin have been captured by either minnow trap or electrofishing in the upper south fork of Getmuna Creek above the barrier. The barrier is located approximately two-thirds of the way up the south fork. The identified barrier is a series of cascades and low falls located within an incised gorge. The highest observed vertical fall (located near the lower end of the gorge) is about 3.75 ft (1.14 m) over a distance of about 15 ft (4.6 m) horizontal. This fall is part of a cascade/fall series that drops about 6 ft (1.8 m) over 50 ft (15.2 m) horizontal without intermediate resting pools. The remainder of the barrier is low head with the bulk consisting of higher gradient cascades (about 6% slope). Modifying this reach by providing resting pools at appropriate locations may encourage more migration up the reach by species in search of potential spawning and rearing habitats that are quite extensive in the upper watershed.

Getmuna Material Site (MS-10)

The material site at the confluence of the north and south forks of Getmuna Creek will consist of a series of eight cells created by excavating material for the proposed access road from the Port to the mine. The cell complex is close to both the north and south forks of Getmuna Creek and could function as an off-channel pond to support fish populations over the winter, as well as augment summer rearing habitat for all species that occur in surrounding reaches of the creeks.

The proposed material site is within a southern aspect alluvial fan. Given that downstream portions of Getmuna Creek successfully support a significant salmon spawning population, it is known that winter groundwater movement occurs within the watershed upstream of the spawning locations. A southern aspect alluvial fan is a highly probable source for such groundwater gain. The downstream "daylighted" material cells would be fed by both the groundwater gain and surface water runoff into the ponds. Over time, the pond would be filled by sediment as well as vegetation and become natural off-channel habitat and eventually wetlands.

Crooked Creek Beaver Dam Removal

There is potential to rehabilitate old stream channels blocked by beaver dams. Low ground pressure vehicles would be used to reduce the onsite impact and to excavate and remove the material. All aspects of removal and creation would be determined in advance, and a detailed map would be created showing the locations of each change. The size of all dams to be removed (height, width, and length) would be detailed on the map. The map would also show pools, other beaver dams, and the apparent obstructions to fish passage. The new off-channel fish habitat locations and overburden waste disposal sites would be identified. A total geo-referenced photo inventory would be produced showing the process of converting the beaver dams and back water areas into fish habitat. The new habitat index would catalog all connections created (depth, width, length, location, and the potential habitat type).

Work would be completed by excavating and grading to specified elevations and grades and to leave the site requiring little to no maintenance.

5.3. Natural Gas Pipeline

Mitigation measures that reduce impacts to EFH along the natural gas pipeline consist of BMPS and timing of construction to work when the species are not present. BMPs would include sediment and stormwater management and monitoring measures that extend from initial mine infrastructure development through mine closure. Sediment control measures to be included in the Erosion and Sediment Control Plan (Natural Gas Pipeline Plan of Development [POD] – Appendix H) would include silt fences, sediment retention basins, cross bars and ditches, runoff interception and diversion, mulching and revegetating disturbed surfaces and soil stockpiles, and other BMPs designed to reduce the intensity of surface runoff, erosion, and sediment loads in downstream drainages.

Mitigation measures to minimize effects on EFH include:

- Minimize the number of pipeline and access road crossings of fish-bearing streams
- Use open-cut methods for stream crossings only at times allowed by ADF&G when spawning fish and fry are not present
- Use temporary bridges to transport construction equipment and materials across fish-bearing streams
- Use pipeline designs and construction scheduling that minimize disruption of fish passage and spawning fish and impacts to fish habitat
- Maintain, to the maximum extent practicable, existing stream hydrologic regimes at fish-bearing stream crossings
- Maintain, to the maximum extent practicable, existing temperature regimes for streams along the corridor
- Use construction methods that eliminate or reduce the potential for bank erosion and sedimentation into fish-bearing streams
- Conduct fueling activity and storage of fuel and related liquids at least 100 ft (30.5 m) from the bank of fish-bearing streams
- Install fish screens on all inlet suction hoses
- Ensure all water discharged from hydrostatic testing meets applicable permit requirements
- Comply with all ADF&G Title 16 permits as well as ADNR Temporary Water Use Permits

- Use HDD methods to cross six major streams, including one each at the Skwentna, Happy, Kuskokwim, East Fork George, George, and North Fork George Rivers. Use of HDD methods would avoid impacts to EFH because the channels will be unaltered.

5.4. Transportation Facilities

As with other proposed Project components, BMPs would be employed to avoid or minimize adverse impacts to EFH during construction, operation, and closure. BMPs include sediment and stormwater management and monitoring measures that extend from initial transportation infrastructure development through mine closure. Sediment control measures to be included in the SWPPP would include silt fences, sediment retention basins, cross bars and ditches, runoff interception and diversion, mulching and revegetating disturbed surfaces and soil stockpiles, and other BMPs designed to reduce the intensity of surface runoff, erosion, and sediment loads in downstream drainages.

Mitigation measures to minimize effects on EFH include:

- Minimize the number of access road crossings of streams that contain fish
- Use span bridges to cross streams containing EFH
- Maintain, to the maximum extent practicable, existing stream hydrologic regimes at fish-bearing stream crossings
- Maintain, to the maximum extent practicable, existing temperature regimes for streams along the access road corridor to avoid affecting fish movements
- Use construction methods that eliminate or reduce the potential for bank erosion and sedimentation into fish-bearing streams
- Conduct fueling activity and storage of fuel and related liquid storages at least 100 ft (30.5 m) from the bank of fish streams
- Install fish screens on all inlet suction hoses
- Comply with all ADF&G Title 16 permits as well as ADNR Temporary Water Use Permits
- Port facilities will be designed to include practical measures for reducing, containing, and cleaning up spills.

6. CONCLUSIONS

6.1. Mine Site Facilities

Long-term adverse effects to Pacific salmon EFH could occur in the middle reach of Crooked Creek near the mine site resulting from altered flow regimes, reduction of in-stream habitat, and reduction in both the connectivity and amount of off-channel habitat. These impacts would be due to altered stream flows resulting from placing fill or constructing flow diversions, pit dewatering activities, and earth movement and grading along tributaries during construction, operation, and closure; thus, would essentially be permanent changes. Moderate adverse effects from flow alteration would mostly affect rearing Chinook and coho salmon and spawning coho salmon in Crooked Creek in the vicinity of the mine. The most significant portion of adult salmon escapement and production in the drainage occurs in Getmuna and Bell Creeks and the lower reaches of Crooked Creek, all of which are not expected to experience adverse effects from mining activities and associated water management practices. Mitigation through reducing the effect of a natural blockage to migration is proposed to increase the extent of EFH in Getmuna Creek. Additional potential mitigation measures are removing beaver dams to re-establish stream channels capable of supporting salmon spawning and connecting the Getmuna Material Site (MS-10) to Getmuna Creek to provide rearing habitat for Chinook and coho salmon. Mitigation on this scale is expected to offset unavoidable habitat loss.

6.2. Natural Gas Pipeline

Anticipated effects to EFH species from along the natural gas pipeline route would involve fish populations downstream of pipeline crossings and along the construction ROW where it is aligned near and upgradient from streams. There are 77 locations along the pipeline route where this occurs. Low levels of impacts are expected from potential habitat degradation from stormwater runoff, suspended solids, and reduced flows caused by disturbed soils and water withdrawals for ice-road construction. No adverse effects to EFH are expected, assuming effective implementation of construction BMPs and implementation of the Title 16 Fish Habitat Permit and ADNR Temporary Water Use Permit conditions. Impacts would be temporary during construction, and would be limited to the immediate vicinity of the stream crossings. Remedial action would be taken at identified problem areas to restore habitat to useable condition. Use of HDD methods for six large river crossings will avoid impacts to fish populations and EFH near those crossings.

6.3. Transportation Facilities

Anticipated potential impacts would be primarily associated with hydraulic forces from propeller wash in the navigation channel. Shoreline erosion during the summer barging season is expected to be minor compared to the naturally high erosion rates documented at spring breakup. Fish displacement and stranding in confined channel segments or along shallow-gradient shorelines, and possible habitat degradation from riverbed scour, are additional potential impacts. Results of studies of juvenile salmon abundance, habitat use, and pattern of outmigration conducted in 2014 and 2015 indicate that impacts to juvenile salmon from these sources are likely to be low. There is a possibility of injury or mortality to juvenile salmon that encounter propeller blades or shear forces in the propeller flow field; however, most juvenile salmon are large enough to avoid encounter with barge propellers and tend to occupy portions of the channel where they are not at risk to propeller strikes. The highest potential for adverse impacts is where the channel narrows and confines the water to a single channel, creating a pinch point where juvenile salmon may be concentrated during the outmigration, which occurs from mid-May to late June.

Overall adverse effects to EFH by the Port facility are likely to be low, and occur mostly during construction. Adverse impacts during operation are related to barge maneuvering during the period of juvenile salmon outmigration. Potential adverse effects to EFH by the mine access road are likely to be low and occur mostly during construction.

For all phases of mine development, there is potential for accidental release of chemicals used in various activities associated with mining. While the probability of spills is low, handling procedures would be implemented to minimize the likelihood of a spill, and response plans would be implemented to address spills that may occur.

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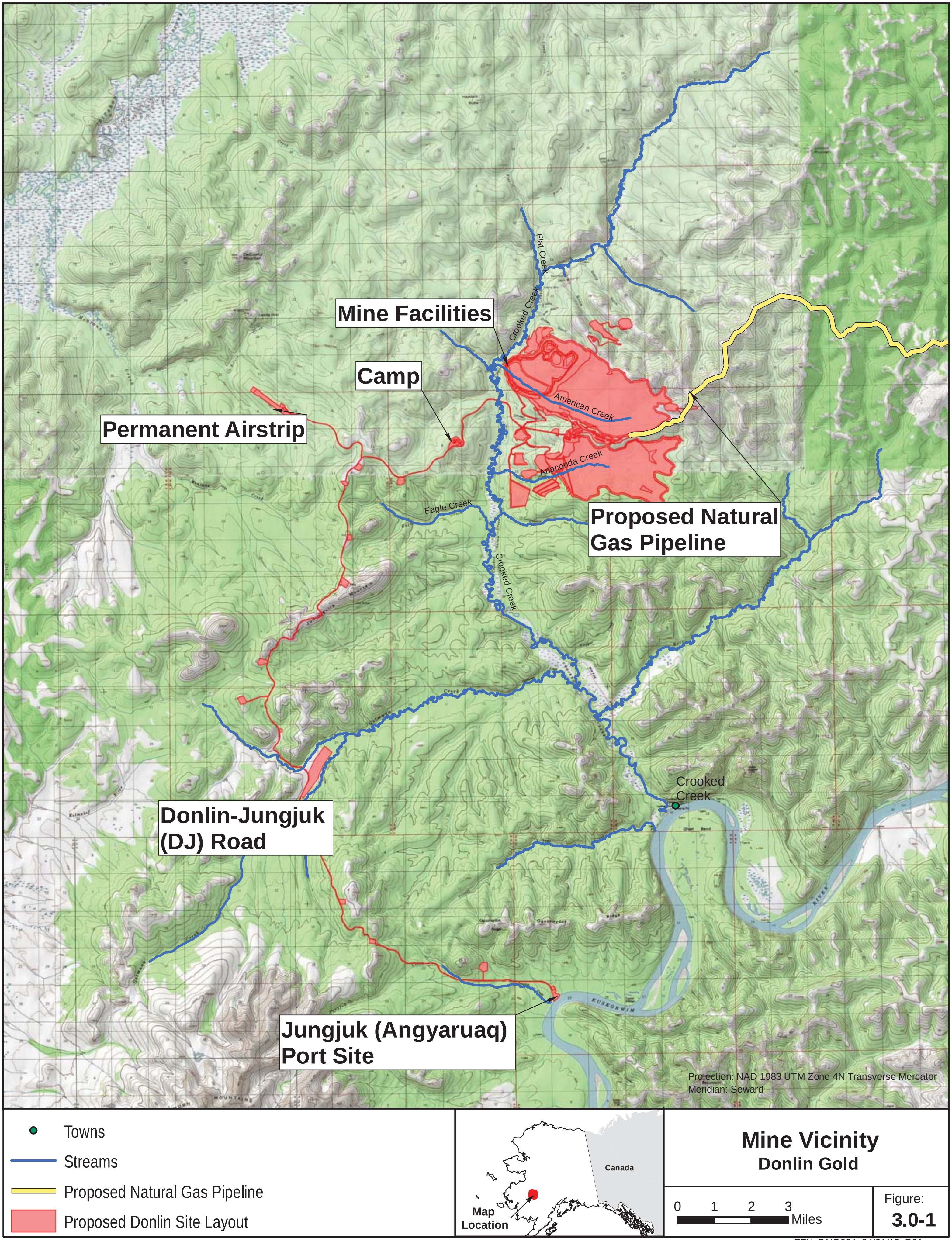
FIGURES

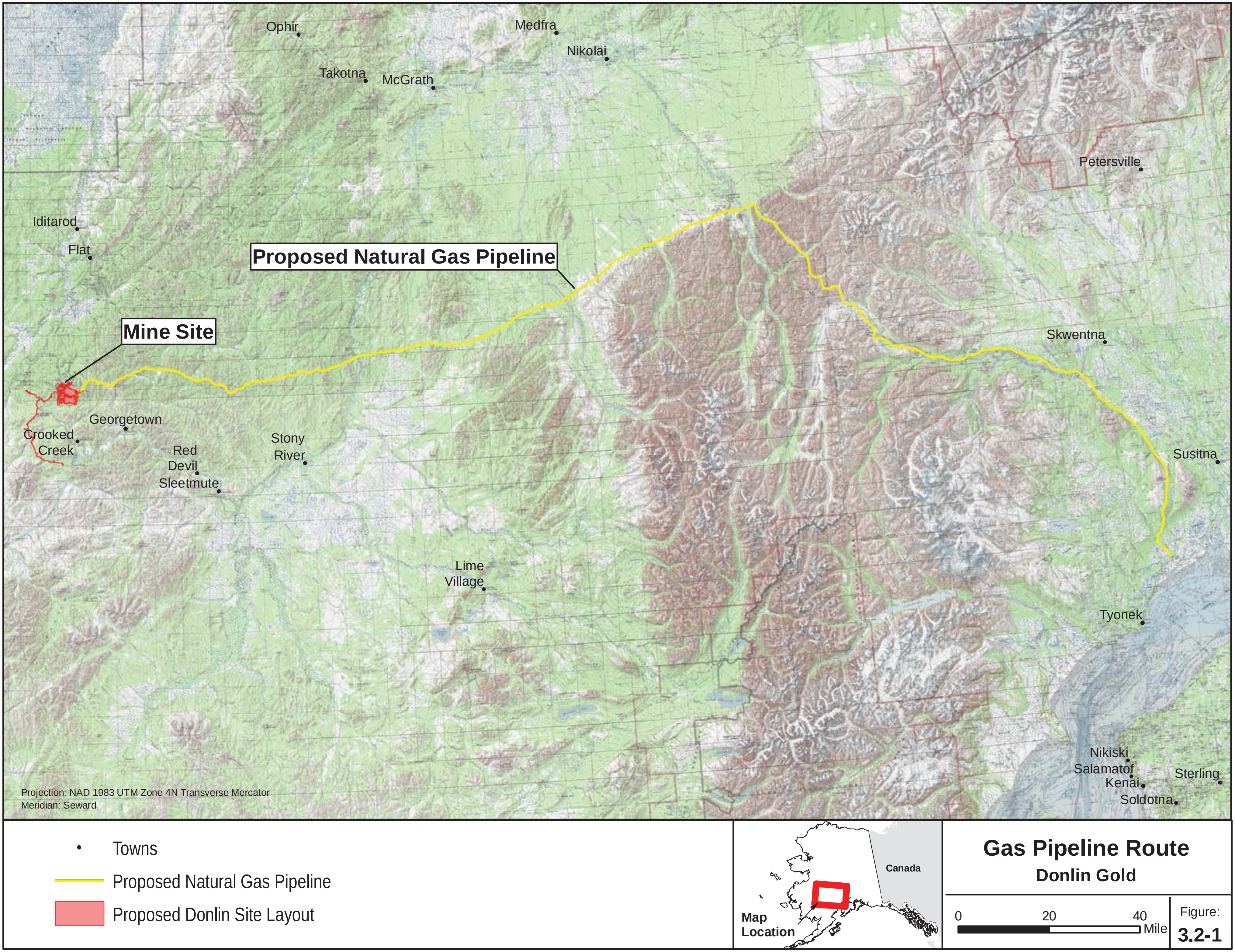


Towns
Streams
Proposed Natural Gas Pipeline
Proposed Donlin Site Layout

Mine Vicinity
Donlin Gold

Figure: **3.0-1**

EFH_DNG004, 04/21/15, R01



Gas Pipeline Route

Donlin Gold

Figure: **3.2-1**

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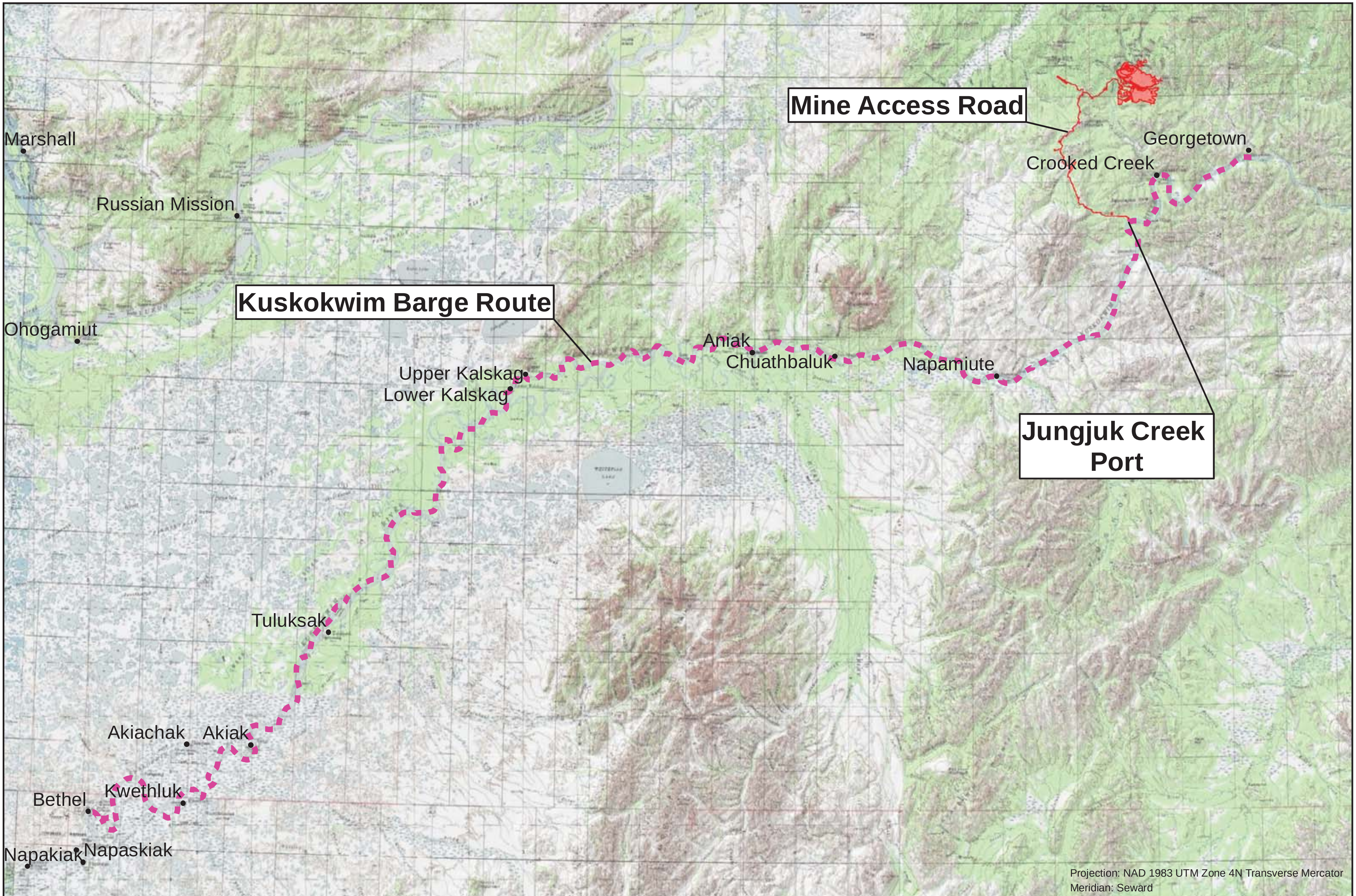

Towns

Barge Route

Proposed Donlin Site Layout

Navigation Route

Donlin Gold

0 10 20 Miles

Figure: **3.3-1**

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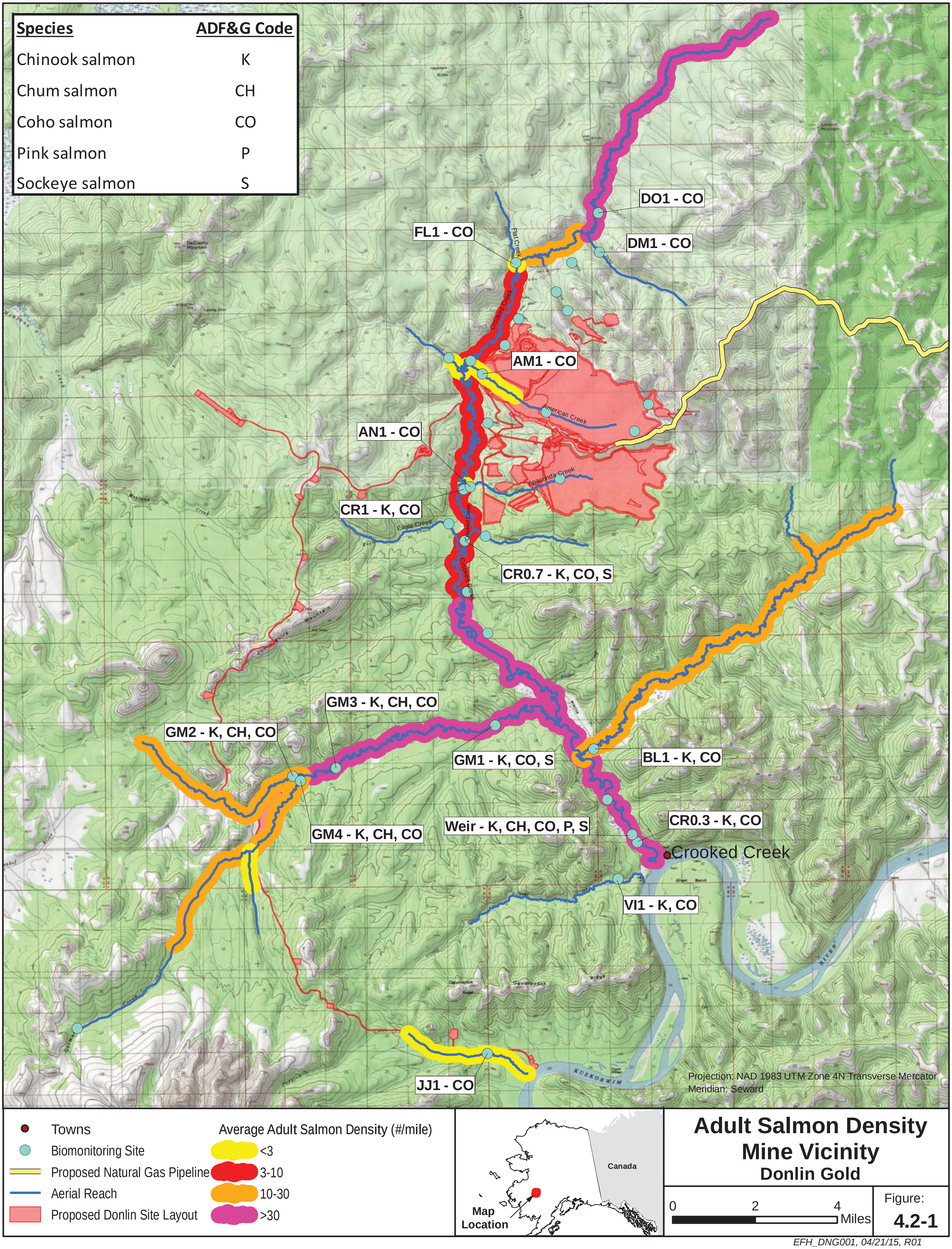


Species
ADF&G Code
Chinook salmon K
Chum salmon CH
Coho salmon CO
Pink salmon P
Sockeye salmon S
DO1 - CO
FL1 - CO
DM1 - CO
Flat Creek
Crooked Creek
AM1 - CO
American Creek
AN1 - CO
Anaconda Creek
CR1 - K, CO
Eagle Creek
CR0.7 - K, CO, S
GM3 - K, CH, CO
GM2 - K, CH, CO
GM1 - K, CO, S
BL1 - K, CO
CR0.3 - K, CO
Weir - K, CH, CO, P, S
GM4 - K, CH, CO
Crooked Creek
VI1 - K, CO
JJ1 - CO
KUSKOKWIM
RIVER
Projection: NAD 1983 UTM Zone 4N Transverse Mercator
Meridian: Seward
Towns
Biomonitoring Site
Proposed Natural Gas Pipeline
Aerial Reach
Proposed Donlin Site Layout
Average Adult Salmon Density (#/mile)
<3
3-10
10-30
>30
Canada
Map Location
Adult Salmon Density
Mine Vicinity
Donlin Gold
0
2
4
Miles
Figure:
4.2-1
EFH_DNG001, 04/21/15, R01

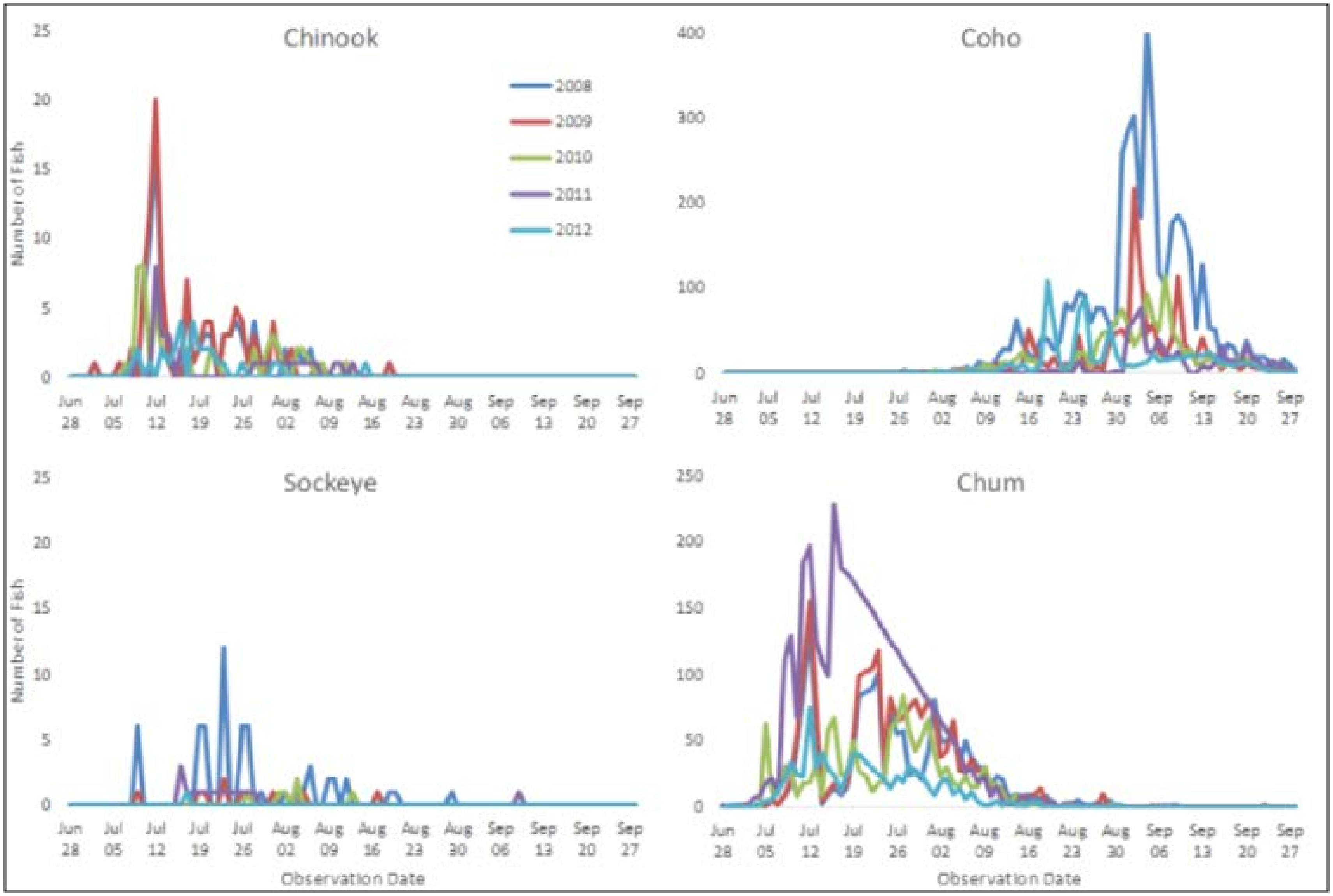
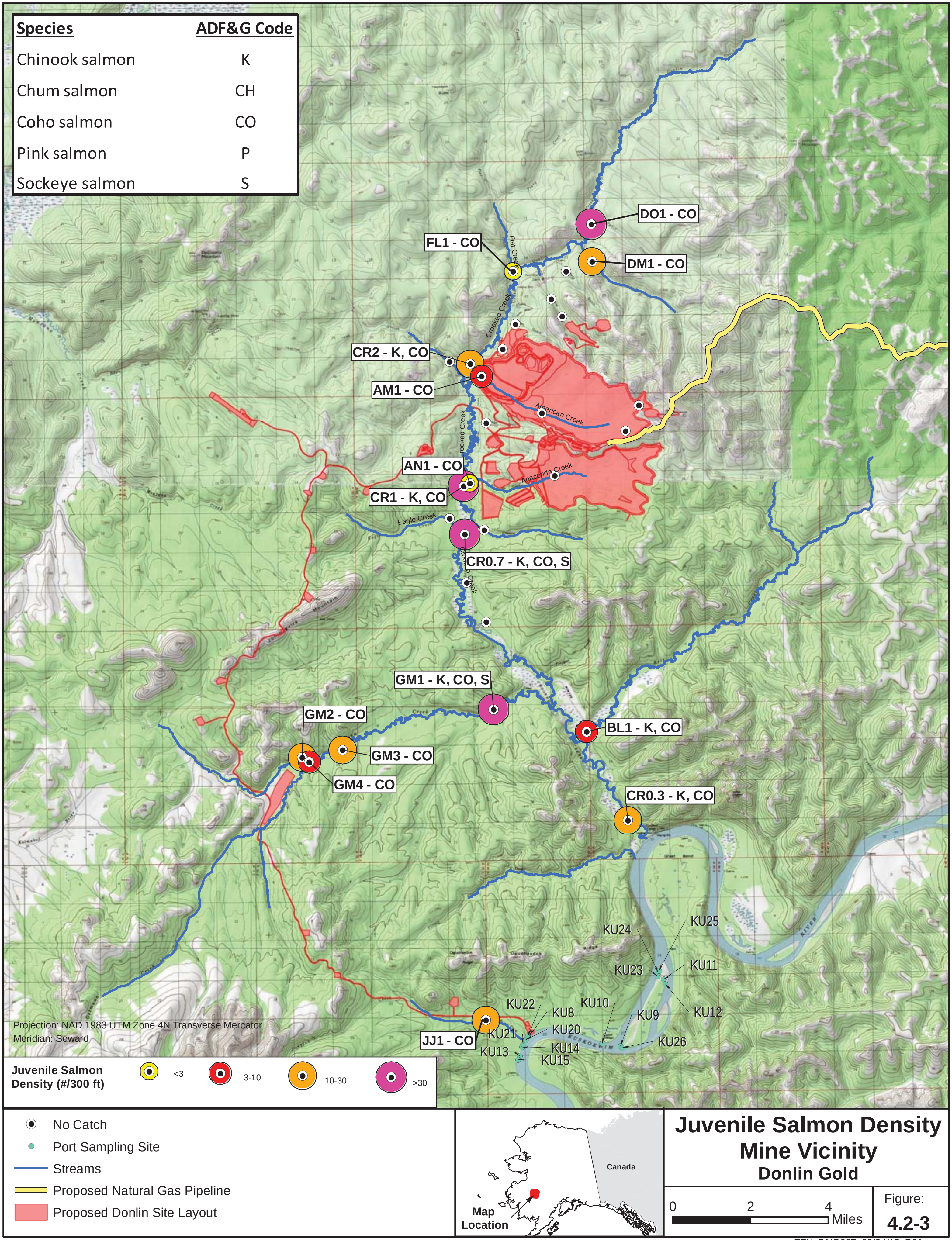


Figure 4.2-2 - Daily Salmon Escapement at the Crooked Creek Weir

Source: OtterTail Environmental (2014a)



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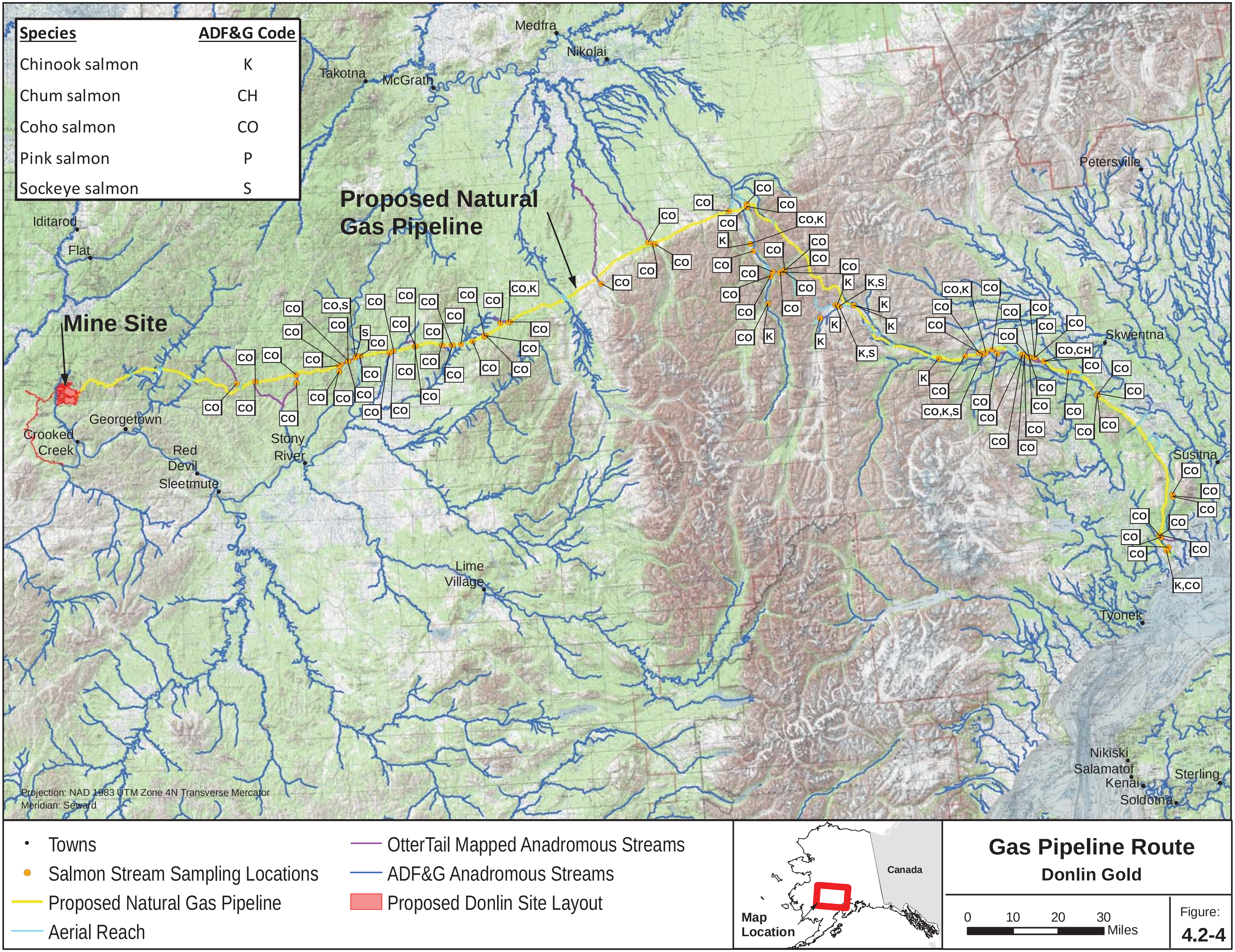
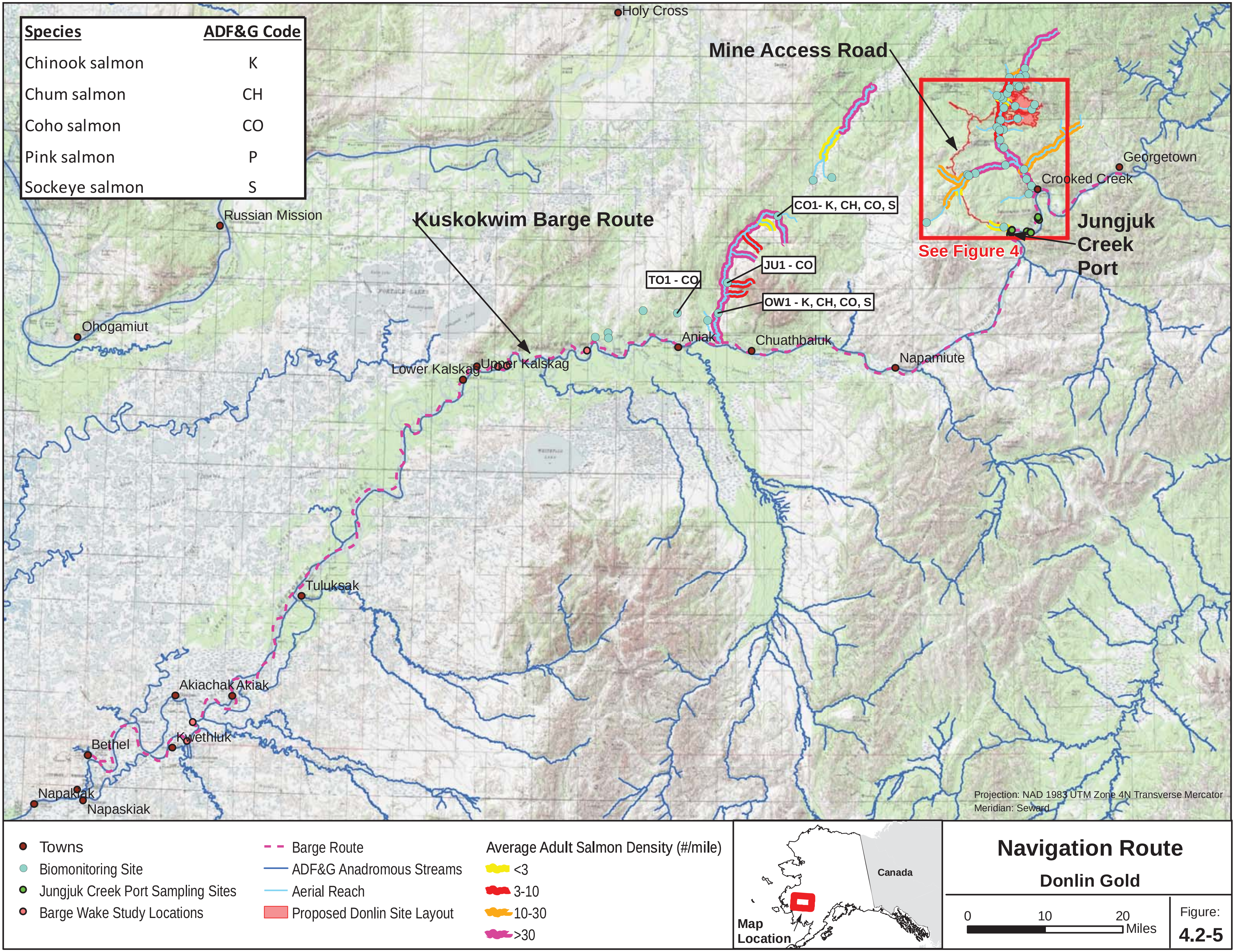


EFH_DNG003, 02/20/15, R00



EFH_DNG002, 02/19/15, R00

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